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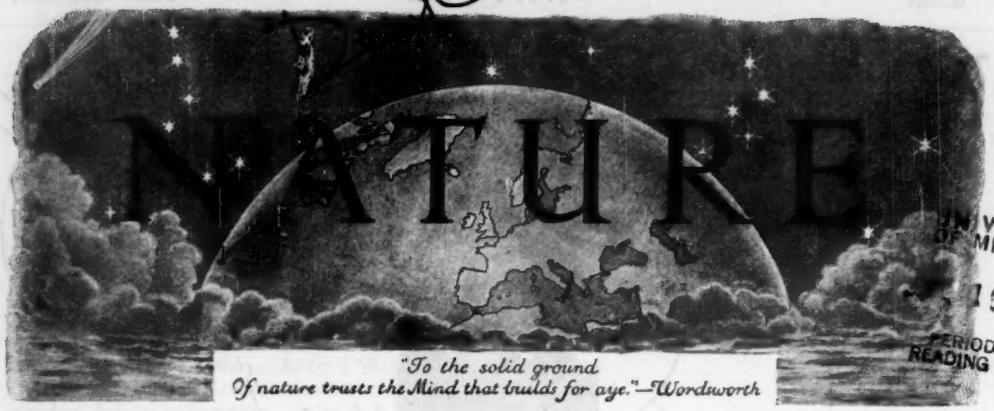

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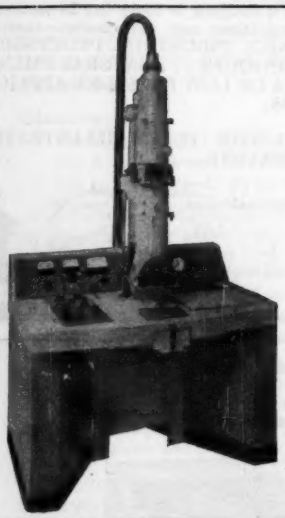

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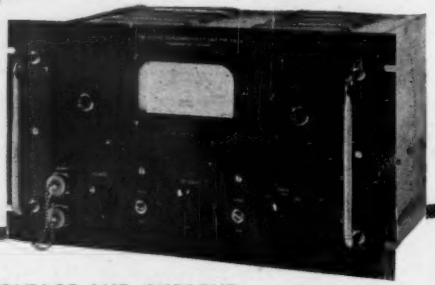

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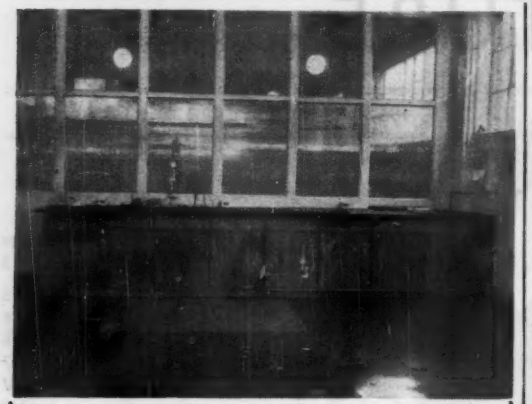
NATURE

No. 4574 SATURDAY, JUNE 29, 1957 Vol. 179

CONTENTS

	Page
Functions of the Press	1313
The Etiology of Command. By E. F. L. Brech	1315
Structure of the Eye. By K. M. Dyce	1316
Thermodynamics in Metallurgy. By Dr. J. W. Evans	1316
Theory and Practice of Humidity Measurement. By Dr. D. W. Hill	1317
Chemical Refining of Petroleum. By Dr. A. R. Bowen	1317
Chemical Analysis. By Dr. A. D. Mitchell	1318
Machines that Handle Information. By R. A. Brooker	1318
Economic Aspects of Forestry. By Sir Harry Champion, C.I.E.	1319
Initiation of Bacterial Transformation. By Dr. Maurice S. Fox and Dr. Rollin D. Hotchkiss	1322
Inheritance of Mental Ability. By Sir Cyril Burt, F.B.A.	1325
Colonial Research	1327
Obituaries:	
Dr. G. B. Jeffery, F.R.S. By Prof. W. R. Dean; Prof. J. A. Lauwerys	1331
Dr. A. J. G. Barnett. By Prof. W. O. Kermack, F.R.S.	1332
Mr. G. H. S. Wood. By Sir Harry Champion, C.I.E.	1332
Mr. L. C. E. Bushby. By Dr. E. Scott	1332
News and Views	1333
Chalk Lime and Allied Industries Research Association	1338
The Karl Pearson Centenary Lecture	1338
Crop Protection. By Prof. H. W. Miles	1339
Some Recent Advances in Spectroscopy. By G. A. Elliott	1340
Colloque A.M.P.E.R.E., 1957. By Dr. J. G. Powles	1343
The Third Law of Thermodynamics. By S. Weintroub	1344
Polyester Wax. By Dr. H. F. Steedman	1345
Amino-Acid Sequence of the α-Melanocyte-stimulating Hormone. By Dr. J. Ieuan Harris and Dr. Aaron B. Lerner	1346
Ion Compression and the Colour of Ruby. By Dr. L. E. Orgel	1348
Letters to the Editors:	
Formation of Erythrose-4-phosphate and Acetyl Phosphate by a Phosphorolytic Cleavage of Fructose-6-phosphate.—M. Schramm and E. Racker	1349
The Free Energy of Hydrolysis of Adenosine Triphosphoric Acid.—G. E. Vladimirov, V. G. Vlassova, A. Y. Kolotilova, S. N. Lyzlova and N. S. Panteleyeva	1350
Blood Anticoagulant Activity of Sulphated Ovular Mucins of Amphibians.—Prof. A. Minganti and G. Bellia	1351
Antigenicity of Antibodies of the Same Species.—Prof. F. Milgrom and S. Dubiski	1351
Rh Antigens and Immunological Tolerance.—H. K. Ward, R. J. Walsh and Olga Kooptzoff	1352
Production of Organ-Specific Antibodies following an Induction of Tolerance to Antigens of Heterologous Organs.—Dr. Michael Feldman and David Yaffe	1353
Demonstration of Cortisol in Fish Blood.—Prof. Philip K. Bondy, G. Virginia Upton and Grace E. Pickford	1354
Adaptive Formation of Nitrate Reductase in Rice Seedlings.—Pei-sung Tang and Hsiang-yü Wu	1355
The Northern Octocoral, *Paragorgia arborea* (L.), in Sub-antarctic Waters.—Prof. Hjalmar Broch	1356
A New Growth-promoting Factor for *Mycobacterium tuberculosis*.—T. Ramakrishnan, Miss M. Indira and M. Sirsi	1356
Systemic Effect of Dieldrin on the 'Body Louse' of Poultry.—Dr. Theresa Clay; P. J. McCosker	1357
Experimental Transmission of *Loa loa* from Man to Monkey.—Dr. B. O. L. Duke	1357
Rhizoctonia Damping-off of some Vegetables in Iraq.—Prof. M. K. Tolba and A. L. Salim	1358
Development of Female *Schistosoma spindale* in the Guinea Pig.—Dr. S. C. Dutt	1359
A New Technique for the Viable Count of Bacteria.—Dr. A. Guha	1360
A Simple Spore Trap.—Dr. R. C. Stephen	1360
Appraisement of Total Activity in Laboratory Animals.—E. G. C. Clarke and A. E. Hawkins	1361
New Routes to Tetrahalomethanes.—Dr. R. N. Haszeldine and H. Iserson	1361
Oxidation of Metals: Determination of Activation Energies.—Dr. Per Kofstad	1362
Preparation of Maghæmite by Electrolysis.—P. T. Davey and Dr. T. R. Scott	1363
Spiral Crystals of Magnesium Sulphate.—M. Shayer	1364
Role of Photons in a Self-Quenching Geiger-Müller Counter.—Prof. Rafi M. Chaudhri, Mustafa Yar Khan and Mohammed Yunas	1364
Vibration Packing of Dry Granular Solids.—J. C. Macrae, P. C. Finlayson and W. A. Gray	1365
Some Early Forms of the Weed Concept.—Dr. Lawrence J. King	1366
Recent Scientific and Technical Books	Supp. vi



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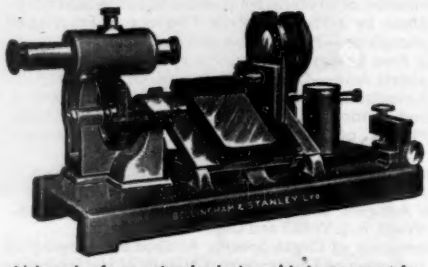

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FUNCTIONS OF THE PRESS

THE debate on the state of the Press in Britain, which was initiated by Mr. J. A. Kershaw in the House of Commons on May 17, was concerned primarily with the maintenance of high standards in a free and independent Press. It derived its wide interest, however, less from certain lapses in standards of reporting which have aroused strong protest than from the reports that several weekly or daily periodicals would be unable to continue publication, in spite of sustained or expanding circulations. To the concern as to the whole future of the Press under modern conditions aroused by such tendencies was added that arising from the pressure which television is likewise exercising on sound broadcasting. Fundamentally, the debate was on the means to be used in the future for the education of public opinion. It was not so much the public influence of broadcasting and the Press, which Sir William Haley discussed in his Clayton Memorial Lecture in 1954, as the influence of television and other factors on broadcasting and the Press, and the means on which we must rely in future for the communication to the public of ideas and news and the stimulation of thought.

Mr. Kershaw, in opening the debate, made a passing reference to the decline of the provincial Press and the tendency towards monopoly encouraged by the rise in costs and growth of mechanization. He was, however, mainly concerned to advance two suggestions to maintain or raise professional standards and avoid some of the recent incidents which have been the cause of protest. First, he suggested that professional standards should be judged, not by the Press Council, which included managerial representatives as well as journalists, but by a sub-committee consisting solely of professional journalists, and secondly, that this body appointed to deal with professional ethics should be enabled to impose sanctions, including the power of suspension or expulsion from the profession.

Neither of these suggestions found much support in the debate. The Joint Under-Secretary of State for the Home Department, Mr. J. E. S. Simon, who spoke for the Government, emphasized, however, that the subject was one for the House as a whole, and pointed out that to give the Press Council, or a sub-committee of that body, the power to impose sanctions would make a grave inroad on the freedom of the Press. Mr. Simon correctly interpreted the general run of opinion expressed in the debate as favouring limitation of the powers of the Press Council to admonition for that reason, though it might still prove that admonition is more effective in ethical matters if it came from a body of purely professional men as Mr. Kershaw suggested. The maintenance of professional standards anywhere is ultimately a matter for the men and women who constitute that profession.

Nevertheless, Mr. Simon seemed a little too complacent about the Press Council. Quite rightly, he pointed out that it has only been in existence a short time, and it is reasonable, as he suggested, to regard it at the moment as experimental. That need not, however, mean ignoring the fact that, as was emphasized in the debate, the Council has not attempted to deal with some serious matters affecting the future of the Press, or prevent the question being asked whether the Council is really the appropriate body to deal with these problems. Mr. Simon recognized that many of the arguments advanced had been put forward in the debate which led to the establishment of the Royal Commission on the Press, and he reminded the House that the Royal Commission reached the conclusion: "The present degree of concentration of ownership in the newspaper Press as a whole or in any important class of it is not so great as to prejudice the free expression of opinion or the accurate presentation of news as to be contrary to the best interests of the public".

Nevertheless, the debate was provoked partly by uneasiness at attempts to repress news or even books, and Mr. Simon weakened his balanced defence of a free society's need for a free Press, with, as a corollary, the possibility that that freedom might be abused, by largely ignoring the fears expressed as to such practices and as to the effect of commercial television on newspapers and periodicals. It is the loss of advertising revenue to television that endangers the future of so many newspapers and periodicals. Since it would seem that television is to a large extent meeting the needs which were formerly met by such publications, it is still important that all the implications of the situation should be faced; a real attempt should be made both to see where all this leads and also whether there may not be some real needs which these newspapers and periodicals formerly met but which television is unable to meet.

In the debate, Mr. W. F. Deedes emphasized that the Press has its own part to play, along with television and radio, in finding new keys to the human mind, and that the Press has to match itself to its share in the task; he paid tribute also to the good work that the Press Council has done in publicizing bad practices. Few speakers, however, really showed the vision displayed by Mr. Deedes, though most were aware that the decision as to the margin between liberty and licence is largely one for journalists themselves to determine. By and large, however, for all the passing recognition that the developments in the British Broadcasting Corporation's programmes which have taken place since independent television was inaugurated are an aspect of this ultimate problem of the communication of ideas, no one penetrated as deeply as Sir William Haley in his Clayton Memorial Lecture.

Perhaps the gravest dangers in this field of mass communication to-day arise from the failure to consider the diverse media in relation to the task for which they are used—their limitations as well as

their advantages. In the three years since Sir William gave this lecture, it has become evident beyond question that television is a major sociological influence of our time, and its presentation of political affairs and politicians and current events is a factor of which not merely sound broadcasting but also the Press must take account. Indeed, current discussion as to the use of television in the schools confirms his observation that the educational purpose of broadcasting is at stake.

If the effect of television on politics and news is likely to be so profound as Sir William Haley predicted, it is still important to remember that, as he points out, much significant and important news has no visual quality. The nature of the medium can in fact be continually at war with the real values of the news, and this position is the more dangerous in view of the evidence which National Service, for example, has produced of the extent of illiteracy. Moreover, if, as Sir William Haley points out, television, broadcasting and the printed word are not mutually exclusive or inimical to each other but complementary, it is desirable that care should be taken to ascertain the best ways in which any new medium can be used for our purposes. It may well yet be held that the decision to permit, at this early stage, commercial television with its concomitant advertising was a great public disservice, a blunder for which the viewer himself as well as the public in general is paying a high price.

However, it is important that not only should the Press, as well as broadcasting and television, have clear ideas to the exact nature of the contribution it can make to the growth of an informed public opinion, but equally that the dangers inherent in each of these media should be clearly understood. Much was said in the debate on May 17 about the dangers of the Press. Little was heard then about the limitations of broadcasting and especially of television, the implications if television does indeed become, for large sections of the population, the whole of broadcasting, and the entertainment and advertising determine both the content and standards of programmes. Moreover, all that Sir William said about the comparative inaccessibility of broadcasting—its limitation in time and place as against its ubiquity—applies with equal if not greater force to television.

These, however, are the considerations which should be determining not simply the content and scope of sound broadcasting and its relations to television but also the use made of television and the content of its programmes. The lead must come from those who are aware of the nature of the medium with which they are working, its possibilities and limitations. In television, as in sound broadcasting, the first condition for wise use of this great new power over men's minds, as Lord Reith recognized from the start, is a sense of public responsibility. Without that we are unlikely to avoid abuse.

That is no less true of the Press, and a real reason for concern at the present pressure on the Press and the way in which rising costs and the loss of advertising revenue are threatening the existence of periodicals as well as newspapers, national and provincial, is the contribution which these papers have made towards the formation of an informed public opinion. Their existence has not merely ensured the possibility of independent comment and facilitated the ventilation of novel, unpopular and even, in their origin, possibly dangerous ideas. Many of them have indeed concentrated on exactly those things which broadcasting could not do, or only with great difficulty. They provided the background, the explanation, exegesis and illustration which are even more essential with television. Some of them sought to maintain a sense of values such as is more than ever needed to-day.

Much of this work, and especially that which promotes public discussion, will not be done if television takes over, though this is not to say that it could not be done by other organs of the Press or by new means. It is at this point that there is room for new and independent inquiry as to the means of communication of ideas, and especially in the mass, though the problem is really a more general aspect of one which the Nuffield Foundation has been assisting the learned societies to face and which could well force a radical change in the means used to-day for the dissemination of ideas, of news, and of opinion. The whole subject calls for fresh creative thinking; and the debate gave a hint too that, perilous as Government action in this field would be, there may well also be need to find some way of dealing firmly but effectively with whatever sectional interests seek to hold the public interest to ransom.

Nor can this problem be dismissed as unrelated to that of raising the standard of public education, and especially technical education, in Britain. The value for the technician and technologist and also for the university graduate of a wide general education is being increasingly recognized. In that education the weekly and daily Press and the serious reviews—which have almost disappeared during the past decade or so—have an essential part to play; and whatever vigour and open-mindedness broadcasting and television bring to the discussion of values and of public affairs, they cannot entirely replace the written word. The state of public education in any sphere depends on the Press, as well as on broadcasting and television, and on the standards and sense of responsibility that the Press brings to its task and the ends it seeks to serve. If, in adapting itself to meet the new stringencies of rising costs by new materials and new techniques, the Press sees clearly its own peculiar opportunities and adapts itself effectively to that task—regarding no limitations imposed from outside, respecting no sectional interest, and accepting no shibboleth as final—it may yet give the public the leadership that is needed and serve the present day and generation as worthily and as potently as ever in the past.

All this is not solely a matter for the Press, and Mr. Simon dismissed the Government's responsibility too lightly. Wisely he was critical of the suggestions made by Mr. Victor Collins, that the larger local

authorities might run municipal newspapers on commercial lines, or that the Government should take a larger share of responsibility for filling gaps in public knowledge, even to the extent of taking space to disseminate important information which would not otherwise be reported adequately. Mr. Simon recognized the danger to the independence of the Press inherent in such methods; but he failed to recognize that the threat is there already in the abuse of advertising, and that it is inherent in Government information services which are now an inescapable responsibility of the Government. This is manifestly one problem which should be under consideration by the Prime Minister's study group to which it is understood that Dr. Charles Hill's report on Government information services has been presented.

Neither for the Government nor for any of the various media—Press, broadcasting or television—will it be easy to draw a line between responsibility and licence, between freedom and sponsorship, between entertainment and information; and if certain sections of the Press or television or broadcasting authorities avoid their public duty, it is, as Sir William Haley said, for informed public opinion to speak out with vision, courage and understanding. In that task the scientist has a vital part to play, partly because of his own knowledge and use of the new methods and techniques of communication and because of his responsibility for their creation, partly because the advance of science itself and the right use of the immense new powers depend so largely upon public understanding and the state of the public mind, and partly because he of all men should understand the importance of informed discussion in reaching sound conclusions or decisions. If the possibilities of the new media are to be fully explored and the contribution which some of the threatened journals have made to informed debate and the formation of public opinion are to be fully appreciated and alternatives are to be tested adequately, it must be by those whose own experience and training have taught them how much is at stake and who will seek to meet the needs of to-day with open and uninhibited minds.

THE ETIOLOGY OF COMMAND

Work and Authority in Industry

Ideologies of Management in the Course of Industrialization. By Prof. Reinhard Bendix. Pp. xxv+466. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 60s. net.

TO characterize this study in succinct form is not easy, for it is neither history nor philosophy *per se*, and yet an admirable combination of the two. Unusual in content and treatment, it offers a discursive analysis of aspects of the growth of industry in the three major units of Britain, the U.S.S.R. and the United States (with a supplementary glimpse of East Germany) in an endeavour to attain a rational explanation of the basic conception of 'authority' as it underlies the manager–worker relationship in the modern structure of each country; "Ideologies of Management in the Course of Industrialization" is the author's sub-title, and a contributed introduction echoes the thesis in the thought that all the countries concerned have the same major problem inherent in their industrial system—"the establishment and preservation of that discipline without which the industrial order degenerates into anarchy". Or put into terms of human motivation: "How can the manager make sure that the worker will follow the rules and regulations? That the worker will exercise good judgment and a sense of responsibility beyond what commands can effect and supervision can control, beyond what incentives can induce or penalties prevent?" The relevance of this thought to the circumstances of Great Britain in particular is compelling.

Society in Western civilization has to a large extent been content to accept the existence of a continuing problem of 'human relations in industry' as more or less inevitable, a kind of inescapable concomitant of the subordination of man to the machine, and as in part the price that has to be paid for the benefits totted up in a rising material standard of living. On the legal plane, society has sought remedies in 'laws of master and servant'; on the psychological plane, it has been content with palliatives of 'consultation broadening into communication'. Nowhere has society tried to delve into causes or attempted to question the facile assumptions on which successive generations of 'managers' have built up their claim to authority. Managers, Prof. Bendix feels, have been invested with qualities that they have not really possessed in order to give logic to the demand that they should be obeyed; and it is, perhaps, to the disillusionment of discovery that we must trace the virulence of feeling when master and servant quarrel.

Analysis of history shows a deeper bedrock of causes below the accepted pattern of authority—a complex closely correlated with the development of the social fabric of the community and with the evolution of the class-system. Thus in Britain, quite early in the process of commercial and industrial development, a firmly established 'middle class' had become the backbone of social living, of government, of wealth, of technical advancement, and of leadership. Their goals became those of the nation—more rightly than he knew could Napoleon classify the populace as one of shopkeepers. Behind the commercial thrust lay also the vigour of political determination directed to 'liberalism', a striving for democracy as a force rather than for the personal liberty of the individual. Through all social grades rights of freedom were sought and fought for, and classes lost their separation to pursue a common cause, even if under labels spelling variously 'reform bills' or 'chartism'. Authority had thus a fluid framework, for its middle-class protagonists and its artisan subjects were always gaining and losing above and below themselves. To the artisan the goal of ambition was to become the self-boss, the capitalist; to the landed aristocrat advancement in trade was an enviable mode, even if it meant clothing oneself in a sordid uniform—the climax in our times has glamorized the drab, and decorated the boards of directors in the process.

Personal goals had even greater force in the United States, emphasized by the more rapid and concentrated growth of industry in generations instead of centuries. "The employer's authority as well as his earnings and privileges are the rewards of past and present exertions; for the people at large, such

rewards are promises held out for the future. Most attempts to increase the *present* satisfactions of work consist of promises of *future* reward." Among those rewards, the attainment of authority over others has always ranked high—carrying with it an acclaim of attainment, an accession to the ranks of the nation's heroes; a kind of universal acceptance of a survival of the mentally fittest, arguing that if by your own efforts you got there you must obviously have what it takes. "The apotheosis of individual effort was seen as the key to all problems of the age."

The U.S.S.R. shows a markedly different pattern from both the others, but the origins of the contemporary tight control over labour lie back equally in the annals of social history for more than a century. Industrial development in Russia during the past century was, of course, on a much smaller scale, but the pattern was as distinct then, on that smaller scale, as it is to-day in the vastness of the five-year plans and the commissariats. Central initiative from the Czar and the few major nobles gave a framework of industrial authority that was autocratic in the extreme. Whether in agriculture or in trade, or in the primitive forms of industry, the peasant and the worker were serfs, little better in personal standing than the slaves of ancient Rome—in a serfdom given a formal sanction in law and persisting unbroken in spirit until the first revolutions on the threshold of our own times. Against this long conditioning no personal development could withstand, and thus the regime of New Economic Policy in the 1920's or Five Year Plans in the 1930's changed only the form of the master, not his spirit. The Russian people were ripe for commissariats and all the close regimen of the Soviet pattern; by Western standards they are hard done by, but in terms of their own social history they enjoy a rigidity of authority in keeping with what they have always known.

Another of the author's fascinating themes is the analysis of the significance of the change from the personal management of the owner-boss to bureaucratic administration in the large organization pattern, with a consequent major increase in the ratio of the 'specialists' to commanders. Here, though, there could be room for argument with the author's conclusions.

A most interesting book indeed, but one for the student rather than for the everyday manager. It has a lot to contribute to the study of industrial human relations, but the contribution may well be found more valuable when distilled through the medium of a course. E. F. L. Brech

STRUCTURE OF THE EYE

Comparative Anatomy of the Eye

By Prof. Jack H. Prince. Pp. ix+418. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, Ltd., 1956.) 63*s*.

THIS book on the structure of the eye should satisfy the wants of most students of comparative anatomy and physiology, since it achieves a nice balance between the bare accounts in the general texts and the lavish detail of the specialist works. It contains a score or more chapters in which the various structures of the globe, the orbit and accessory organs and the visual centres are described and each of these includes a discussion of the chief differences in the various classes of vertebrates with emphasis upon the adaptations necessary to different ways of life. Additional chapters are devoted to the invertebrate eye and to technical methods, while a final table summarizes the salient features that characterize the different groups.

The subject is covered adequately and is presented well, although occasionally general principles are obscured by digressions on specific peculiarities of doubtful significance. One sees little, however, to account for the suggestion that the special needs of veterinary students have been particularly considered, and the material selected shows no bias toward any group of animals. The style is lucid, but the appearance of the text is marred by an indiscriminate and irritating use of italics. The illustrations are numerous; many, however, are poor and could be omitted with small loss. Despite these criticisms, this book can be recommended as a useful introduction to the complexities of the vertebrate eye.

Unfortunately the author has not been content with this success, but has attempted, by the inclusion of additional material, to provide references for the specialist also. Much of this information is of doubtful value and its inclusion is regretted, since it must have contributed to a price which appears unreasonably high. K. M. Dyce

THERMODYNAMICS IN METALLURGY

Metallurgical Thermochemistry

By Dr. O. Kubaschewski and E. Ll. Evans. Second edition, completely revised and reset. (Metal Physics and Physical Metallurgy: an International Series of Monographs, Vol. 1.) Pp. xiv+410. (London and New York: Pergamon Press, Ltd., 1956.) 55*s*. net.

Thermochemical Data of Alloys

By Dr. O. Kubaschewski and Dr. J. A. Catterall. (Pergamon Science Series: Metal Physics and Physical Metallurgy—an International Series of Monographs, Vol. 3.) Pp. iv+200. (London and New York: Pergamon Press, Ltd., 1956.) 45*s*. net.

THE first edition of "Metallurgical Thermochemistry", published in 1951, already enjoys a considerable reputation and this second revised edition meets the need for including new thermodynamic values in the extensive collection of data which forms a large and useful part of the book. The concise theoretical introduction now has two new sections dealing with non-regular solutions and slag-metal reactions. The other major part of the book is concerned with the experimental methods of metallurgical thermodynamics (for example, calorimetry, electromotive force and gas-metal equilibria), which are discussed in detail with numerous diagrams.

The tabulated data relating to metals, metal compounds and alloys constitute a most comprehensive collection; among the properties listed are heats of formation, entropies and heat capacities which make it possible to estimate free energy data for a wide variety of systems. A selected number of free energy equations are given, as well as partial molar quantities for many alloys. In such a compilation errors are inevitable; the following have come to the reviewer's attention: on p. 334 the free energy equation for ammonia should be $\Delta G^\circ = -12{,}050 + 26{\cdot}7\,T$;

on pp. 354–55 the data for oxygen in tin appear quite wrong and based on a misinterpretation of the original work. Among the copious references, Coughlin's recent publication (U.S. Bureau of Mines Bulletin, No. 542; 1954), which includes complete free energy and other data for a large number of oxides, appears to have escaped the authors' critical net.

Other minor sections of the book, particularly that dealing with the estimation of thermochemical data, enhance its value. It can be confidently recommended to all research workers concerned with the high-temperature reactions of metals and their compounds as well as to senior students interested in chemical metallurgy.

"Thermochemical Data of Alloys", by Drs. Kubaschewski and Catterall, forms a natural, if rather expensive, appendix to "Metallurgical Thermochemistry". The authors present a critical assessment (with more than five hundred references) of the available data relating to more than two hundred systems. The tabulated values of heats, entropies, free energies and volume changes are mainly confined to intermetallic systems but there is a short collection dealing with the transitional metals alloyed with oxygen, sulphur, carbon, nitrogen and phosphorus.

This survey brings out clearly the dearth of thermodynamic data on alloys in general, and one is impressed by the very few systems for which there exist complete partial molar heats and entropies over the entire composition range in the solid and liquid state.

Many of the data in this book are concisely presented in "Metallurgical Thermochemistry". While the more detailed and expanded treatment has real value, this separate volume does not fully justify itself at this price when compared with the first volume of the series.

J. W. Evans

THEORY AND PRACTICE OF HUMIDITY MEASUREMENT

Hygrometry

By Dr. H. Spenser-Gregory and E. Rourke. Pp. xv+254. (London: Crosby Lockwood and Son, Ltd., 1957.) 36*s*. net.

SOME processes in chemical engineering require that measurements of low relative humidity should be made with a precision that can be met only by methods of the utmost refinement. On the other hand, it is a peculiarity of hygrometry that some of the earliest and crudest methods are still used because they are convenient and sufficiently accurate for the purpose: the description of a method attributed by the authors to Leonardo da Vinci could well be that of an instrument recently introduced in the textile industry. It is appropriate, therefore, that the authors of this book (the first of whom died within a few days of its publication) should have devoted the first quarter to a short historical preface and an introductory chapter which briefly describes the principles of the available methods of hygrometry. This section will be particularly useful both to students and others who are making their first serious acquaintance with hygrometry.

The chapter on the vapour pressure of water and ice leads to the frost point hygrometer and its application to low-temperature hygrometry, and another on the vapour pressure of solutions examines critically the published values of vapour pressure for the sulphuric acid–water mixtures frequently used in studying the performance of hygrometers. The theory of the moisture content of highly compressed permanent gases receives a chapter to itself.

Svennson's theory on the wet and dry bulb hygrometer is the basis of a chapter on psychrometric theory, with particular reference to Assman's psychrometer. The authors extend this theory and apply it to the Gregory balanced temperature psychrometer, pointing out the advantages of this method that arise from its simplified theory. Further chapters deal similarly with the theory and characteristics of dew point, hair, diffusion, gravimetric and electrolytic hygrometers.

The authors have justified the all-embracing title chosen for the book, and readers will find theory, practice and experimental results on most aspects of the subject. Perhaps the least satisfied will be the reader who has to decide which of the many available methods he should employ for a particular purpose. Much of what he requires can be found or deduced, but the value of a further edition would be enhanced by a summary of the conditions for which each of the methods is most suitable, the present status of the methods with respect to accuracy and stability, and their commercial availability. This comment should not be allowed to deter anyone with any kind of interest in hygrometry. So far as the reviewer is aware, this is the most comprehensive book on the subject, and the clarity with which the material has been presented will ensure that those who seek information on any aspect of hygrometry will be quickly rewarded.

D. W. Hill

CHEMICAL REFINING OF PETROLEUM

Petroleum Refining with Chemicals

By Vladimir A. Kalichevsky and Prof. Kenneth A. Kobe. Pp. xi+780. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1956.) 95*s*.

AN informative treatise on the subject of the chemical and physico-chemical refining of petroleum fractions. A scientific survey of refinery operations is always a difficult task owing to the variation and complexity of crude oils. It will be surprising to many to know that as many as 2,300 products are marketed by refineries. The origin of crude petroleum is not known; however, the optical activity of some fractions point, at least in part, to bacterial action on organic remains. The chemist is always conscious that crude petroleum constitutes a vast source of chemical raw material and should thus be used to the best advantage. Lower fractions and refinery by-products are now used extensively in chemical industries. A great deal is known to-day of the properties of the lower hydrocarbons but little is known of the structure of the hydrocarbon constituents of the higher fractions of petroleum.

The recognized processes of chemical refining of distillates are fully recorded and the limitations and advantages in acid refining and refining with alkalis are discussed. Adsorbents are used effectively with distillates either in the vapour or liquid state according to circumstances. Synthetic adsorbents tend to be

costly. Sulphur removal and sweetening of distillates are always important. Catalytic cracking can be a desulphurizing process. The problem of corrosion in refinery equipment is a subject that receives attention.

Information on solvent extraction of petroleum fractions presents features of wide interest. Distillation processes can alter the more complex constituents. Selective extraction of oil fractions appears to offer one way of partial resolution of the groups of components. In this way fractions in the lubricating oil range, for example, can be resolved into wax, pseudo-waxes, good grade oil, indefinite oil, poor grade oil, resins and asphalts. The principles of extraction processes have been investigated to some extent mathematically. The book is intended for the beginner and advanced student, the plant operator and supervisor and research worker. The approach to each section justifies the first claim and the 8,000 literature and patent references (mainly American) justify the claim with regard to advanced students and research workers. The plant operator and supervisor could obtain more indications of the relative economics of the many refinery processes from the original literature quoted.

Like other industries, the petroleum industry introduces new terms for some of its processes, for example, 'platforming': the catalytic reforming of distillates in the presence of platinum. 'Cycloversion' is not explained but its function is apparent. Fuels, including jet engine fuels, are described and their characteristics and rating. The empirical nature of most marketed petroleum products is inevitable and so is their improvement by means of additive agents functioning as oxidation inhibitors, anti-detonants, pour point depressants, viscosity-index improvers, oiliness carriers, rust preventives, anti-foam agents and fluorescence improvers.

The literature quoted is extensive and up to date, and it is good to notice that it includes the work of such pioneers as B. Redwood, L. Edeleanu, A. E. Dunstan, G. Egloff, J. C. Morrell, G. A. Burrell, B. T. Brooks, L. Gurwitsch and H. I. Waterman.

A. R. Bowen

CHEMICAL ANALYSIS

Advanced Analytical Chemistry

By Prof. Walter Wagner, Prof. Clarence J. Hull and Prof. Gerald E. Markle. Pp. v+282. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1956.) 48*s*. net.

THIS book is compiled with a view to part of the requirements of certain American universities (particularly that of Detroit) for a master of science degree in which analytical chemistry is offered as a major subject. It does not appear to be suitable for any course now current in British universities.

Part 1 (104 pages) is devoted to analytical techniques, covering organic reagents, gas analysis, colorimetry and spectrophotometry, polarography and amperometric titrations, chromatography and ion exchange techniques, thermogravimetric analysis, radiochemistry, and statistics. It will be obvious that each aspect can receive only a very cursory treatment, but the eighteen pages given to statistics are clearly written and give a fair idea of the problems involved. In the sections on colorimetry and spectrophotometry, and polarography and amperometric titrations, a large proportion of space is taken up with photographs of the cases of commercial instruments with dials and knobs: it would have been much more instructive to give, as is done for thermogravimetric analysis, a line diagram to explain the essential features.

Part 2 (158 pages) deals with sixty-nine elements grouped, for some unexplained reason, as in the Periodic Table. For each element the following data are given: atomic number, atomic weight, specific gravity, melting point, and boiling point. Then follow tests (in some cases) and brief mention of various possible and sometimes interesting volumetric and gravimetric methods of determination, one of the latter being given in some detail; these methods are often such as I would not choose, but that is a personal matter.

Each section in Part 1 concludes with a bibliography, and each element in Part 2 is similarly documented. These bibliographies give a few references to early work and a small but representative selection relating to more recent work. The book is well produced and there are few misprints. In their preface the authors forestall certain criticisms, but nevertheless the book leaves an impression of extreme superficiality.

A. D. Mitchell

MACHINES THAT HANDLE INFORMATION

Computers

Their Operation and Applications. By Edmund Callis Berkeley and Dr. Lawrence Wainwright. Pp. x+366. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1956.) 64*s*. net.

THIS book may be regarded as a sequel to E. C. Berkeley's "Giant Brains" published in 1949, and attempts to summarize some of the developments which have taken place since then. In such a rapidly expanding field, however, it has become impossible for any single author to become familiar with, or even to have heard of, every development, so that the picture it gives is necessarily incomplete and superficial. Nevertheless, the book is useful to anyone not working directly in the field himself who wants to obtain an overall picture of automatic computing machinery and its applications. The contents are as follows.

Section 1 is an introduction and gives a list of automatic computers in operation in Europe and the United States. Section 2 is an account of the logical structure of an automatic digital computer, describing the principles of storage, number representation and arithmetical operations, programming and the control unit, input and output, reliability and maintenance. This section concludes with a check-list of the characteristics of a computer which is intended to serve as a guide to the suitability of any computer for a particular job.

Section 3 (written by Wainwright) is a general account of analogue computers, and covers mechanical linkages, differential analysers (mechanical and electronic), harmonic analysers and models of all kinds. Section 4 lists various kinds of digital information processing systems, ranging from traffic-

light controllers to race-course totalisators, in order to show the importance and versatility of automatic machines for handling information. The component parts of such machines are simply the storage mechanisms and arithmetical units, etc., already described in Section 2, but connected in a particular way to suit a particular purpose.

Section 5 is mainly an account of a very simple machine (SIMON) which the author (E. C. Berkeley) built to illustrate the principles on which full-scale machines operate. The machine employs electromechanical relays and is almost small enough to be regarded as an educational toy to be built from a 'home-construction kit'. Section 6 describes some of the machines which have now become commercially available in the United States (and in Britain, too, if people can afford them). These include the UNIVAC, I.B.M. types 701, 702, 704, 705, and the ERA 1103.

Section 7 discusses possible applications of computers and is probably the most fascinating part of the book. The authors start by listing the occupations in which people earn their living chiefly or partly by (routine) mental work, and considering to what extent they can be replaced by machines. All kinds of business applications are suggested, including payroll computation, sales analysis, production scheduling and stock control. It will be clear from this that their use in computation laboratories, which is to a large extent the main location of such machines in Britain, will account for only a small fraction of their total employment. Moreover, if digital calculators are linked up to other kinds of machinery, for example, machine tools, then it is possible to envisage a very wide field indeed (automation).

Section 8, the last part of the book, contains a list of references to books, periodicals and other sources of information about automatic digital computing machinery, a list of organizations (mainly in the United States) making computers, and finally a glossary of terms and expressions used in the literature.

R. A. BROOKER

ECONOMIC ASPECTS OF FORESTRY

Economics of Plantations

By W. E. Hiley. Pp. 216. (London: Faber and Faber, Ltd., 1956.) 25*s*. net.

Profitable Forestry

By Lord Bolton. Pp. 126 + 9 plates. (London: Faber and Faber, Ltd., 1956.) 15*s*. net.

ONLY a few years ago it would have been true to say that there was a serious dearth of English books on forestry. Schlich's famous "Manual of Forestry", published in five volumes between 1889 and 1896, with later—not very basically—amended editions of the two more popular volumes on "Silviculture" and "Management", was until the 'twenties the only comprehensive account. During the 'thirties the one important addition was Hiley's "Economics of Forestry" (1930), though a series of American monographs on the major aspects began to appear from the McGraw-Hill Publishing Company. Of books suitable for the interested layman, we had only Ackers's "Practical British Forestry" (Oxford Univ. Press, 1938). Of recent years, however, there has been a rapid advance, particularly in the category of books aiming at presenting the major issues of forestry to the important class of owner-managers and land-agents. Now within a year we have from the same publisher two books by very well-known authors, one writing chiefly for the professional and the other for the amateur, describing and discussing the financial and economic aspects of forestry with special reference to conditions as we have them in the United Kingdom.

Hiley's new book is a natural development of part of the earlier one referred to above and his "Woodland Management", making a most thorough examination of the relative returns to be expected from plantations under the wide range of conditions encountered in practice, and the range of species and treatments that appear to be suitable for a given site. As indicated on the dust jacket, the author concludes that "we might halve the cost of growing trees of sawmill size", as compared with current practice, in both State forests and private woodlands. The means for doing this are three-fold, namely, more appropriate choice of species to be grown, much heavier thinning procedure, and shorter rotations. The implied criticism of State forest policy, or at least practice, is severe, though it is admitted that there are complications and practical difficulties such as quality of land available, amenity considerations and the prescribed requirement for holding a large standing stock of timber against a natural emergency. In Hiley's view, his recommendations could usually be applied without significant infringement of these requirements, and despite the limitations involved. Foresters are very well aware that they can obtain far better plantations and get much better returns on good land than on poor land, and that from the economic point of view a considerably higher price for the former—higher than tends to be viewed as the present acceptable limit—is justifiable. The rejoinder that it is not the national policy to compete with agriculture for the better land must be accepted, but Hiley is justified in insisting that on much of the poorer land a profit should be possible under his methods where at present there seems little or no chance of any. The case is certainly made out for systematic research to determine how far these procedures will give satisfactory results under the poorer conditions, the doubt chiefly concerning the tree's power of rapid response to more growing-space.

Lord Bolton, with his long experience as a leading owner-manager, is in full agreement with Hiley on the question of the need for heavier thinning. There are also good grounds for his view that there is an urgent need for improvement in methods of marketing timber and other forest produce, which have been even more neglected by the owners than has thinning; inadequacies in this direction have been a major factor in the widespread belief that forestry does not pay. Individual markets should be sought and middlemen avoided, and the opinion is expressed that sale by private treaty has points over sale by tender, because goodwill is so important in times of low prices and poor markets. In view of the fact that 82 per cent of British woodlands are in private ownership, Lord Bolton's book should be of considerable importance not only in giving an interesting and easily read general account for the interested layman, but also for the stress put on the practical aspects of the work. It should be encouraging to the hesitant that he is able to illustrate many important points from his own confessed mistakes.

H. G. CHAMPION

Spot Tests in Organic Analysis

By Dr. Fritz Feigl. Translated by Dr. Ralph E. Oesper. Fifth, enlarged and revised English edition. Pp. xx+616. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1956.) 55*s*.

IN the earlier editions of Prof. Feigl's texts on spot tests, organic reactions were treated as supplementary to inorganic reactions; later his studies in the organic field led to the appearance in 1954 of Vol. 2 of "Spot Tests", dealing with reactions for qualitative organic analysis. The present edition, the fifth, now appears as a book in its own right and contains much new material.

Prof. Feigl rightly points out that information regarding interferences that may suppress or confuse a test for an organic compound or group is often lacking, and that the degree of reliability is less than in inorganic analysis. He appeals for a scientific approach, rather than an unintelligent use of a 'collection of recipes'. More than one-quarter of the contents of the present volume is occupied by the chapter on the detection of functional groups. Some classical tests are included, and the nitroprusside test for ketones provides a good example of the critical treatment evident throughout the book: the nitroprusside reaction is now stated to be due to the isonitrosation of CH_2— groups and not characteristic of methyl ketones. Subsequent chapters deal at greater length than in the earlier edition with the identification of individual organic compounds and the application of spot tests for technical purposes, including the identification of medicinals and antibiotics. C. O. Harvey

Progress in Radiobiology

Proceedings of the Fourth International Conference on Radiobiology held in Cambridge during 14–17 August, 1955. Edited by Joseph S. Mitchell, Barbara E. Holmes and Cyril L. Smith. Pp. xii+557. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 63*s*. net.

THE chapters of this book give evidence of the wide range of disciplines which are successfully applied in radiobiological research. After a lucid introduction to radiochemical thinking, showing how free radicals formed very closely together can be intercepted by organic molecules, the Conference discussed our knowledge of physical and chemical events following the absorption of ionizing radiations of different linear energy transfer. In general, the chemical efficiency of radiation decreases, while its biological efficiency increases, with increasing linear ion density. A series of papers dealt with the effects of small doses on substances of biological interest and on the metabolism of single cells or whole organisms. The problem of chemical protection appears to become more of a physiological question, involving changes in the oxygen supply to tissues. The 'oxygen effect', the effects on bone and radiation carcinogenesis still offer a wide range of fundamental questions, but have already proved of practical importance in radiotherapy. Human data were analysed both statistically and in detail for individual observations of radium-poisoning. They should be read as a warning against the indiscriminate use of X-ray sets and of radioactive material. Genetic studies are slowly elucidating the topical problem of radiation effects on large breeding populations of bacteria and insects as well as those of plants and mice. The chapter on studies of spleen, bone marrow and blood is of very special interest since we witness the last stages of the controversial question: Which of the elements of the hæmopoietic tissue are the responsible agents for protection against total body irradiation? The book is well produced, and it is to the editors' credit that much of the spontaneity of the recorded discussion has been preserved.

M. Ebert

Aberrations of Thin Lenses

An Elementary Treatment for Technicians and Students. By H. H. Emsley. Pp. xvi+352. (London: Constable and Co., Ltd., 1956.) 50*s*. net.

A NUMBER of the older English works on aberration theory were restricted to a treatment using only elementary mathematics; this tradition is continued here, following in general Conrady's methods. Some knowledge of elementary optics is assumed, and the book is mainly concerned with the primary aberrations of thin lenses, leading up to the design of an objective and simple eyepiece for a prism binocular, and a thorough discussion of spectacle lenses. The presentation is clear, worked examples being given at each stage. The use of only elementary algebra, geometry and trigonometry involves loss of brevity and greatly restricts the scope of the work; thus the formulæ for the primary aberrations of oblique imagery are quoted but not derived, and though there is a short chapter on aspheric surfaces, the primary aberrations of these are not treated. The extent to which a technician with very limited mathematical knowledge is likely to be concerned with lens designing is perhaps debatable; certainly for a university student one of the rather more advanced text-books would be preferable.

The book contains a number of mistakes: for example, the coma diagram (p. 165) is wrong; the statement on pp. 71 and 203 that no shape of thin lens reduces the primary spherical aberration to zero is incorrect for a range of virtual object or image positions; normal eyepieces, including that designed in the text, do not have over-corrected primary field curvature, as suggested on p. 214. It is surely misleading to quote Maxwell's definition of a perfect optical instrument (p. 145) without adding that he proved it could not exist except in the case of a telescope of unit magnification. C. G. Wynne

Physics

By S. G. Starling and Prof. A. J. Woodall. Second edition. Pp. xvi+1328+11 plates. (London and New York: Longmans, Green and Co., Ltd., 1957.) 55*s*. net.

SOME rewriting, a certain amount of new matter, a list of suggestions for further reading, and numerous additional examples for solution are the chief alterations made for the second edition of this excellent and well-established text-book. While small in themselves, these changes should add considerably to the book's usefulness as a sheet-anchor for students taking the less-specialized kind of degree course in physics, and lend some weight to the suggestion that boys might profitably use it for scholarship work at school. There is some sound advice both in the preface and in the reading list, and the student who masters the contents of the book and acquires its outlook will be well equipped indeed.

G. R. Noakes

Inorganic Microanalysis—Qualitative and Quantitative

A Short Elementary Course. By Dr. Ronald Belcher and Dr. Cecil L. Wilson. Second edition. Pp. ix+153. (London and New York: Longmans, Green and Co., Ltd., 1957.) 21*s.* net.

THIS book is a revised and enlarged edition of that appearing under a more restricted title in 1946 (see *Nature*, **158**, 79; 1946). The main new feature is the introduction of quantitative work, and although, as the authors state, this aspect of micro-methods is not yet so well developed as the qualitative aspect, they are to be congratulated on their pioneer efforts to put this before students. Owing to the economy of material in all such methods, the authors suggest that really rare metals (as opposed to so-called 'rare' metals) could well be included in courses of instruction, for even the six metals of the platinum group could be covered at relatively small expense. It is to be hoped that they will include these in a later edition.

The sixty-nine pages devoted to qualitative analysis start with twenty-two pages describing apparatus and technique, which are well illustrated with numerous clear diagrams. The remaining forty-seven pages cover the usual tests for cations and anions, about sixteen pages dealing with methods avoiding the use of hydrogen sulphide, sodium thiosulphate being substituted and the necessary precautions in its use being emphasized. The section on gravimetric analysis starts with some thirty pages on the balance and apparatus, which again are clearly described. Then follow details of sixteen typical determinations. Titrimetric analysis is introduced by fourteen pages on apparatus and its calibration, and nine typical titrations follow. Electrochemical deposition is then dealt with in ten pages.

As there is so little for adverse criticism in this excellent book, perhaps I may be forgiven for pointing out that the spelling 'radicle' is not favoured by standard dictionaries and was abandoned by the Chemical Society about fifty years ago.

A. D. MITCHELL

Fundamental Concepts of Algebra

By Claude Chevalley. (Pure and Applied Mathematics: a Series of Monographs and Textbooks, Vol. 7.) Pp. viii+241. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 6.80 dollars.

THOSE who believe that mathematics is essentially a language will immediately appreciate Chevalley's view, that algebra is not so much an end in itself as the language of mathematics, by which mathematical facts and logical patterns can be expressed in a standard form. Algebra must therefore be sensitive and responsive to developments in other mathematical domains; it must also be general and therefore highly abstract. From the basic notion of a set of elements to which a binary composition law applies, associating with any ordered pair of elements of the set some single element, it is possible, by laying restrictions on the nature of the composition, and by introducing a second binary composition, to build up gradually from monoids to groups, to rings and to modules, and thus arrive not only at a plurality of algebras but at a precise definition of what we mean by an 'algebra'. This is Chevalley's main theme, illustrated in the final chapter by some instances of associative algebras. The argument is careful and necessarily precise, but its abstract nature demands intense concentration from the reader; it is therefore surprising to learn that the book represents an algebra course of only one year. After graduation the young student may progress more rapidly than those familiar with the algebra of yester-year. The new sea of abstraction facilitates progress, but in submerging the old obstacles it has also submerged the old landmarks. The old-fashioned mathematician who is resolute to acquire the new discipline must begin by forgetting Chrystal, Weber and Bôcher; some of the beauties of sail must be sacrificed to the austerities of modern power.

T. A. A. BROADBENT

The Electrolytic and Chemical Polishing of Metals in Research and Industry

By W. J. McG. Tegart. Pp. x+129. (London: Pergamon Press, Ltd., 1956.) 30*s.* net.

A GREAT number of research scientists have good cause to bless the name of Jacquet, to whom, more than anyone else, the invaluable technique of electrolytic polishing owes its development. However, in practice, knowledge of the existence of such a technique and the successful application of that technique to a particular problem can often be separated by a deep gloomy chasm. The present book should do much to eliminate such frustration, as it describes in simple terms methods of applying the technique of electrolytic polishing to a great variety of metals and alloys. However, the author has not neglected to discuss the underlying mechanism and to outline general principles which should help in the development of new electrolytic polishing methods where needed. There is a cautionary chapter on the hazards associated with the use of perchloric acid, a common constituent of laboratory electrolytes. While the emphasis of the book is primarily on the research side, three chapters deal specifically with the already numerous industrial applications of electrolytic and chemical polishing methods. These can be recommended to industrial metallurgists who may be seeking ways of replacing costly and tedious finishing methods using abrasives.

R. W. K. HONEYCOMBE

Demography and Addendum to Demography

By Peter R. Cox. Second edition. Pp. xii+314+viii+64. (Cambridge: At the University Press, 1957. Published for the Institute of Actuaries and the Faculty of Actuaries.) 25*s.* net.

THIS is a re-issue of the text-book which was first published in 1949, bound together with the "Addendum", previously issued separately, which carries the story forward to 1954. It is written primarily for actuarial students preparing for their professional examinations and therefore tends to treat the subject from a fairly formal point of view, touching only briefly on the sociological and economic aspects of demography. Moreover, the exigencies of the actuarial syllabus decree that the theory and construction of life-tables are to be treated in a different text-book, and demography without life-tables is rather like Hamlet without the prince. However, given these limitations, the book remains one of the very few texts on the subject in the English language, and represents a competent and workmanlike approach to the study of human populations which others, besides budding actuaries, will find useful and valuable.

INITIATION OF BACTERIAL TRANSFORMATION

By Dr. MAURICE S. FOX and Dr. ROLLIN D. HOTCHKISS
Rockefeller Institute for Medical Research, New York City 21

TRANSFORMATION occurs when a population of pneumococci is treated with deoxyribonucleic acid from a genetically different strain and is manifested by the appearance in the population of cells carrying the different genetic characteristic. Since the property of receptivity to treatment with deoxyribonucleic acid is a transient one in a growing population of bacteria[1,2], kinetic analysis of the interaction between the bacteria and the nucleic acid has heretofore been difficult.

A technique has been developed in this laboratory which permits the preservation of receptive cells for long periods of time. The preservation is accomplished by permitting a population of pneumococci to grow to the appropriate physiological state (at a density of about 10^7 bacteria/ml.) and freezing aliquots in 10 per cent glycerol. The cells thus prepared are maintained in a freezing-cabinet at about − 20° C. Such cells remain viable for at least eighteen months, and retain receptivity for as long as three months.

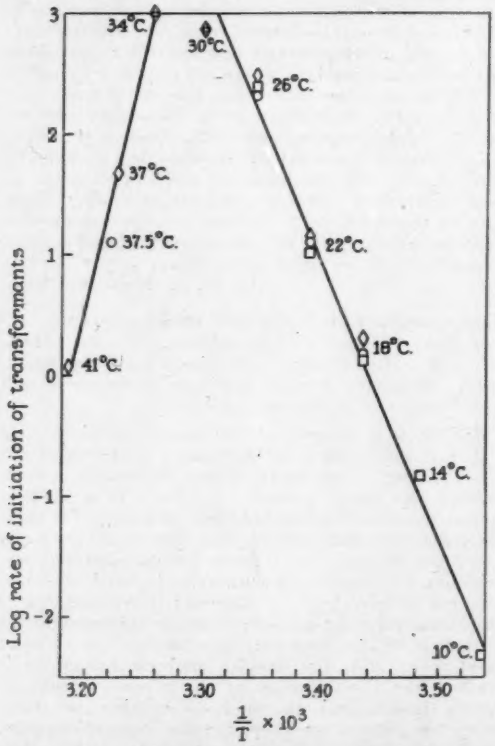

Fig. 1. Effect of temperature on the rate of initiation of transformation; plotted as the logarithm of the rate versus the reciprocal of the absolute temperature. Bacterial density 4×10^8/ml., deoxyribonucleic acid concentration 0·3 γ/ml. The different symbols represent separate experiments

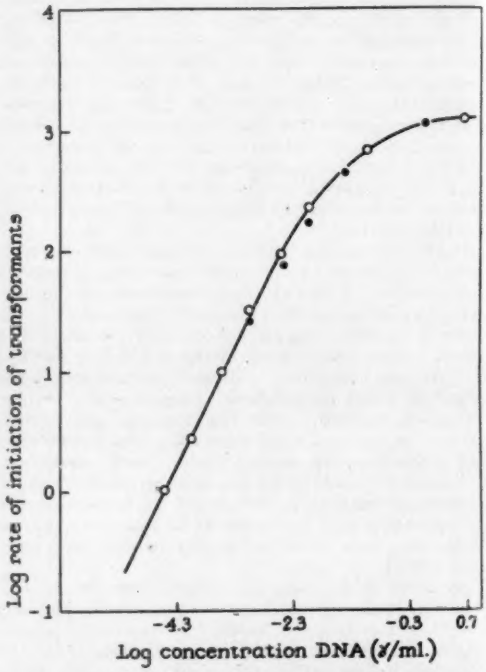

Fig. 2. Effect of deoxyribonucleic acid concentration on the rate of initiation of transformation at 30° C. Bacterial density 4×10^8/ml. The different symbols represent separate experiments

Dilution of a freshly thawed culture into growth medium followed by the addition of an appropriate nucleic acid preparation yields a suspension in which, after a short induction period, the number of transformants increases linearly with time of exposure to deoxyribonucleic acid. This linear increase persists for more than one hour, during which time the cells have not yet begun to divide.

In addition, it has been found that under the conditions described the rate of increase of transformants with time is sensitive to temperature and the commonly used 37° C. is not optimal. Fig. 1 is a plot of the logarithm of the rate of initiation of transformants versus the reciprocal of the absolute temperature. The slope of the line on the low-temperature side of the maximum corresponds to an activation energy of about 20 kcal./mole for the overall reaction resulting in bacteria irreversibly initiated on the pathway toward transformation. The decline of the logarithm of the rate with increasing temperature, above 34° C., indicates that some reaction or reactions unfavourable to the initiation of transformation begin to predominate.

The experiments are carried out by adding nucleic acid to the bacteria at the chosen temperature,

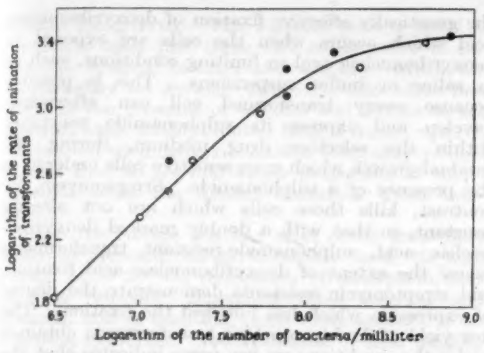

Fig. 3. Effect of bacterial density on the rate of initiation of transformation at 30° C. Deoxyribonucleic acid concentration 10^{-3} γ/ml. The different symbols represent separate experiments

removing aliquots at various times, terminating the interaction with deoxyribonuclease, and incubating at 37° C. for 2 hr. to permit expression of the new property, in this case streptomycin resistance.

Since it is near the optimum, 30° C. has been chosen as the temperature at which further kinetic experiments were carried out. Fig. 2 describes the rate of initiation of transformants as a function of concentration of deoxyribonucleic acid. At low concentrations of deoxyribonucleic acid the rate is directly proportional to concentration and at high concentrations saturation of this rate occurs. A similar linear increase and saturation of rate occur when the density of bacteria is varied at a constant low concentration of deoxyribonucleic acid as seen in Fig. 3.

Such saturation curves for rates of initiation of transformation can be interpreted in terms of a rapid reversible adsorption of the nucleic acid to the bacteria, followed by a slow irreversible incorporation. Assuming such a model,

$$B(s) + \text{DNA} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} B(s)\ \text{DNA complex} \xrightarrow{k_3} B(tr)$$

where $B(s)$ represents the concentration of bacterial adsorption sites, which are assumed to be proportional to the number of bacteria, DNA represents the concentration of deoxyribonucleic acid molecules, and $B(tr)$ represents the concentration of cells in which transformation has been irreversibly initiated. The k's represent reaction rate constants for the respective reactions and K is defined as $(k_2 + k_3)/k_1$.

Such a reaction sequence can be treated as a conventional enzyme–substrate reaction. Setting up this relationship, it can be demonstrated that it is symmetrical with respect to both concentration of deoxyribonucleic acid and concentration of bacterial adsorption sites.

Applying a Lineweaver–Burk[3] treatment, a plot of the reciprocal rate of initiation of transformation versus the reciprocal concentration of deoxyribonucleic acid for concentrations sufficiently high that they are not changed appreciably during the reaction yields a $V_{max.}$ and a K for the reaction. The $V_{max.}$ is equal to $k_3[B(s)]$; and K for the complex between the bacterial sites and the nucleic acid in units of γ deoxyribonucleic acid/ml. is equal to 4×10^{-3} γ/ml. (Fig. 4).

A similar treatment of the reciprocal rate of the initiation of transformation versus the reciprocal of

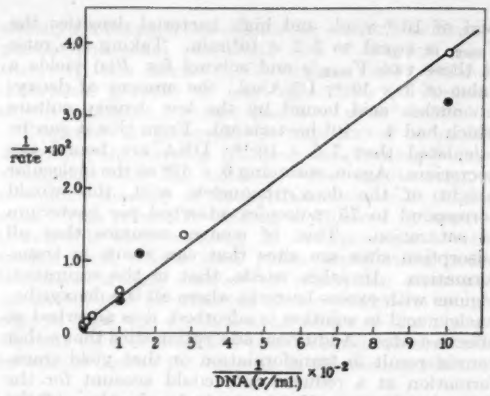

Fig. 4. Determination of K and $V_{max.}$ of the reaction between bacteria and deoxyribonucleic acid at high acid concentrations, 4×10^8 bacteria/ml., at 30° C. The different symbols represent separate experiments

the bacterial density at high bacterial density (deoxyribonucleic acid concentration limiting) yields a $V_{max.}$ which is equal to k_3[DNA]; and a K in units of bacteria/ml. of $1{\cdot}2 \times 10^8$ (Fig. 5). Since these K's are for the same reaction, their ratio yields the maximum amount of deoxyribonucleic acid that can be adsorbed per bacterium. The ratio is equal to $3{\cdot}3 \times 10^{-16}$γ DNA/bacterium. Assuming a molecular weight of deoxyribonucleic acid of 6×10^6, thirty-three such molecules would be adsorbed to each bacterium. Another independent way of calculating this number is by relating the two $V_{max.}$ values. The $V_{max.}$ for 4×10^8 bacteria/ml. at high concentrations of deoxyribonucleic acid is equal to 10^3/min. At a concentration of deoxyribonucleic

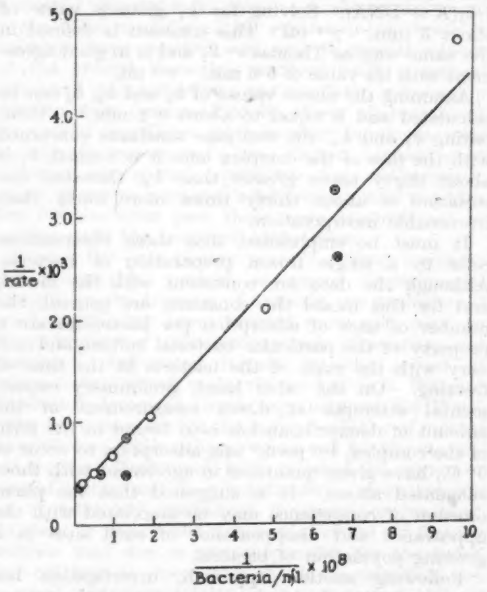

Fig. 5. Determination of K and $V_{max.}$ of the reaction between bacteria and deoxyribonucleic acid at high bacterial densities, 10^{-3} γ/ml. deoxyribonucleic acid, at 30° C. The different symbols represent separate experiments

acid of 10^{-3} γ/ml. and high bacterial densities the $V_{max.}$ is equal to $3{\cdot}2 \times 10^{9}$/min. Taking the ratio of these two $V_{max.}$'s and solving for $B(s)$ yields a value of 3×10^{-4}γ DNA/ml., the amount of deoxyribonucleic acid bound by the low density culture which had 4×10^{8} bacteria/ml. From this it can be calculated that $7{\cdot}5 \times 10^{-13}$γ DNA are bound per bacterium. Again, assuming 6×10^{6} as the molecular weight of the deoxyribonucleic acid, this would correspond to 75 molecules adsorbed per bacterium at saturation. This, of course, assumes that all adsorption sites are sites that can result in transformation. In other words, that in the saturation regions with excess bacteria where all the deoxyribonucleic acid in solution is adsorbed, it is adsorbed at effective sites. Additional adsorption sites that either cannot result in transformation or that yield transformation at a reduced rate could account for the difference between the two calculated values of the number of sites per bacterium, although it is as yet doubtful whether this difference is significant.

If the quantity of deoxyribonucleic acid adsorbed per cell transformed were known, it would be possible to calculate k_3. From experiments with transforming deoxyribonucleic acid labelled with phosphorus-32 it is known that a minimum[4] of $2{\cdot}1 \times 10^{-5}$γ of deoxyribonucleic acid is irreversibly incorporated by the treated cell population per cell transformed. Assuming this value for the deoxyribonucleic acid preparation used in these experiments, k_3 is about 6×10^{-2} min.$^{-1}$.

Still within the framework of the model, the evaluation of k_1 and k_2 can as yet only be made very crudely. If it is assumed that the induction period prior to the linear rise of initiation of transformants with time is the time required for the equilibrium to be established, a treatment introduced by Gutfreund[5] may be applied to evaluate k_1. Following this treatment, extrapolation of the linear rate to zero transformants yields a time which is equal to $1/k_1(K + \text{DNA})$. Solving for k_1 gives a value of about 5 min.$^{-1}$ γ^{-1} ml. This constant is defined in the same way as Thomas's[3] k_2 and is in good agreement with his value of 6·6 min.$^{-1}$ γ^{-1} ml.

Assuming the above values of k_1 and k_3, k_2 can be calculated and is equal to about 0·2 min.$^{-1}$. Comparing k_2 and k_3, the two rate constants concerned with the fate of the complex once it is formed, k_2 is about thirty times greater than k_3, therefore dissociation is about thirty times more likely than irreversible incorporation.

It must be emphasized that these observations refer to a single frozen preparation of bacteria. Although the data are consistent with the model, and for this model the constants are general, the number of sites of adsorption per bacterium are a property of the particular bacterial culture and will vary with the state of the bacteria at the time of freezing. On the other hand, preliminary experimental attempts at direct measurement of the amount of deoxyribonucleic acid bound in the form of the complex, by permitting adsorption to occur at 0° C., have given quantities in agreement with those calculated above. It is suggested that the phenomenon of competence may be associated with the appearance and disappearance of such sites in a growing population of bacteria.

Following another approach, investigation has been made into the biochemical nature of the process by which deoxyribonucleic acid becomes adsorbed to cells. Using the transformable property, sulphonamide resistance, it becomes convenient to measure the genetically effective fixation of deoxyribonucleic acid which occurs when the cells are exposed to deoxyribonucleic acid in limiting conditions, such as in saline or buffer suspensions. This is possible because every transformed cell can afterwards develop and express its sulphonamide resistance within the selective drug medium, during the residual growth which even sensitive cells undergo in the presence of a sulphonamide. Streptomycin, by contrast, kills those cells which are not already resistant, so that with a doubly marked deoxyribonucleic acid, sulphonamide-resistant transformants reveal the extent of deoxyribonucleic acid fixation, and streptomycin-resistants demonstrate the degree of expression which has followed the fixation. The low yield of doubly resistant transformants obtained under the conditions we are using indicates that the once transformed cell has a no greater than average probability of becoming transformed to a second property.

Pneumococci growing in an adequate medium are not optimally responsive to deoxyribonucleic acid unless two additional factors are supplied. Transformation of this species seems to fail without the addition of a serum factor best supplied in the form of various purified serum albumins[6], and calcium ions (10^{-2}–10^{-4} M) appear to be almost equally decisive. When these components are optimal, physiological factors, such as the stage of culture growth[7] or stage of cell division attained, also play a part in determining responsiveness. Cells brought into a state of high transformability through 'phasing' at lowered temperatures rapidly lose this state when growing at 37° C. and then regain it with a cyclical periodicity believed to be related to cell division cycles[1]. When such cells grown in media containing albumin are incubated in growth medium deficient in serum albumin, they also lose this property within a few minutes, but they do not regain it when the incubation is continued in the absence of albumin. This behaviour suggests that the cells in becoming transformable combine with or in some other way make a recurrent and temporary use of the serum albumin.

Cultures frozen as described above will later reflect the degree of transformability which they had attained just before freezing, so that cultures frozen in a phased state are highly transformable, and on the basis of the model presented above may be assumed to have more adsorption sites than unphased ones. During about ten days at − 20° C., susceptible cells gradually cease to be immediately reactive with deoxyribonucleic acid added just after the frozen culture is melted. On incubation at 37° C. such once transformable cells regain a receptive state in about 20 min., but will lose it again in a further 20–30 min. This behaviour is reminiscent of phased growing cultures, but the frozen cultures provide the additional advantage that the cells can be exposed to deoxyribonucleic acid under environmental conditions widely different from those under which they grew into a receptive state. Not only can the interaction be measured as already described, at temperatures below those optimal for growth, but also the frozen cultures may be diluted into simple saline solutions altogether inadequate for growth.

In brief, the cells can fix deoxyribonucleic acid (in the sense of being irreversibly started on a process which can lead to subsequent genetic expression) even when they are not able to grow, but expression has so far only been observed under conditions

suitable for growth. The fixation process itself is dependent upon just those two components of the complete system, calcium and albumin, which are not necessary for growth. Although cells which had grown in the presence of calcium and bovine serum albumin, when freshly diluted from a frozen culture, still reacted with deoxyribonucleic acid, they yielded about a five- to ten-fold larger proportion of transformants when the diluent contained these components.

When the culture has lost most of its immediate reactivity toward deoxyribonucleic acid through storage at − 20° C., re-creation of adsorption sites becomes critically dependent upon calcium and albumin, and in addition, upon what appears to be a protein synthesis. The formation of sites binding genetically effective deoxyribonucleic acid in a form resistant to nuclease: (*a*) requires presence of a mixture of amino-acids; (*b*) requires, or is facilitated by, glucose as an energy source; (*c*) is independent of growth; and (*d*) is completely inhibited by about 1 μgm./ml. of chloromycetin, a relatively specific inhibitor[8] of protein synthesis. The conditions therefore resemble those developed in this laboratory to reveal protein synthesis in resting staphylococci[9]. Irreversible fixation of deoxyribonucleic acid via sites already synthesized can occur in an albumin–calcium–glucose–potassium phosphate (*p*H 7·5)–saline mixture. In this mixture cells remain viable without detectable growth, or any expression of streptomycin resistance, for more than 5 hr. at 30° or 37° C.

Evidence is presented in support of a model describing the reaction between transforming deoxyribonucleic acid and bacteria. The results suggest reversible binding of deoxyribonucleic acid to the cells. This reversible binding is followed by a slow irreversible step resulting in incorporation of the nucleic acid, which then yields transformed cells. Increases in the number of adsorption sites per bacterium can be observed under conditions which suggest that the formation or repair of such sites depends upon a process of protein synthesis that can be carried out by the bacteria in the resting state.

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INHERITANCE OF MENTAL ABILITY*

By Sir CYRIL BURT, F.B.A.

Professor Emeritus of Psychology in the University of London

DURING the First and Second World Wars, Dr. Walter Bingham played a leading part in devising, and in putting into effect, the ingenious scheme for classifying personnel in the American Fighting Services by the aid of psychological procedures. The original 'Army Mental Tests', compiled under his supervision, have provided one of the most popular models for the intelligence tests used in Britain for selecting pupils at the age of eleven for entrance to secondary grammar schools. In the course of his work for the United States War Department, Bingham became more and more convinced that, under ordinary peace-time conditions, there was a vast and unsuspected waste of human ability as a result of the imperfect methods of educational selection and vocational guidance[1]; and, by the terms of his will, he left funds from his own estate in order to encourage, by the institution of lectureships and other means, the study of this problem.

In Britain, as a result of the new arrangements introduced by the Education Act of 1944, the problem has come once again to the fore. Fifty years ago the traditional method of discovering bright and promising pupils was still based on scholarship examinations in the ordinary school subjects. Most British psychologists had by then accepted the attractive theory originally formulated by Francis Galton[2]: namely, that, during childhood at any rate, intellectual efficiency in all directions is determined mainly, though not entirely, by a single general factor called 'general ability', and that differences in this ability are largely the effect of the individual's genetic constitution. This has several practical implications. Up to the prepubertal period, it seemed reasonable to place each elementary pupil in the same class for all his subjects; the mentally defective were certified and sent to special schools on the ground that they suffered from a general deficiency in intelligence; and similarly, scholarship children were presumed to be clever all round. A few special disabilities, such as word blindness, were occasionally recognized; and Galton himself cited evidence for special aptitudes—for mathematics, music, literary or artistic achievement, and the like. But for the most part these were assumed not to mature until the onset of adolescence.

During the past twenty years, however, owing to the remarkable success of recent experimental research on the training of animals, the attention of psychologists has been directed more and more to the possibility of improved methods of teaching and learning. Influenced largely by the school of behaviourism, which under the lead of J. B. Watson[3] dominated American psychology between the Wars, many have even denied the very possibility of mental inheritance; while others, influenced by the statistical work of Thurstone[4], have rejected the notion of general ability and have substituted a miscellaneous set of relatively specialized 'primary' or 'unitary' abilities. It was indeed this revival of the old faculty doctrine that was in part responsible for the belief that children at eleven plus should be classified, not so much according to the degree of general ability, but rather according to the kind of special aptitude that each appeared to show: thus the 'abstract type', whether of a literary or mathematical bent,

* Substance of the Walter Bingham Lecture, delivered at University College, London, on May 21.

was said to be suited for a grammar school; the 'technical' type for the technical school; and the 'concrete' or 'practical' type for the secondary modern school.

But quite recently, psychological research, often on entirely novel lines, has been tending to rehabilitate much of the old beliefs, with the added recognition that both the psychological and the genetic problems involved are far more complicated than psychologists of 1910 were inclined to suppose. The doctrine of distinct and independent abilities has hitherto drawn much of its support from the early experiments on cerebral localization, which seemed to indicate that sensory, motor and linguistic functions could be assigned to definite centres within the brain. These findings appeared to be further corroborated by maps of cortical cell structure published later by histologists, such as Campbell, Brodmann and von Economo. Their conclusions, however, have since been severely criticized by such Continental workers as Bok and Lorente de Nó, and by Sholl in Britain. The latest studies of the microscopic structure of the human brain have directed attention to the wide differences in cell-architecture between one individual brain and another, and have shown that many of the alleged local differences are more or less accidental consequences of variations in growth, in blood supply, and in the surface curvature of the cortex. It would thus appear that, in the same individual, nerve tissue, like every other tissue—hair, bone, muscle and skin—tends to be of much the same general quality throughout, with only minor local variations. Even if we cannot unreservedly accept Lashley's theory of the 'mass action' of the brain, nevertheless the facts that he reports are much more in keeping with Galton's hypothesis of general ability and minor special abilities than with Thurstone's doctrine of major 'special abilities' and no general factor. Dr. Sholl himself concludes that 'intelligence', like retentivity, is a "general attribute of all cortical tissue". Finally, this interpretation is independently confirmed by wide-scale statistical investigations, based on applications of the procedure known as 'factor analysis' to actual assessments obtained for various types of intellectual proficiency[5].

If, therefore, differences in this general capacity are the result of differences in brain structure, we should expect that, like other physical differences, they would largely depend on hereditary transmission, and that the mode of transmission would be that which obtains in the case of almost all physical characteristics, namely, the method described by Mendel's laws. The most conclusive evidence is that furnished by investigations among children of school age, for whom the requisite data are most readily procured. Where two alternative factors such as heredity and environment are likely to be involved, the obvious procedure is to keep first one and then the other as constant as possible, and observe the results. In orphanages and other institutions, it is possible to find children brought up under much the same environmental conditions almost from birth. Contrary to expectation, it is found that the individual differences, so far from being diminished, vary over an even wider range. In the majority of cases they seem to be associated with differences in the intelligence of the parents. Many of the brightest, for example, prove to be illegitimate children whose father, often a casual stranger, was himself of a high intellectual ability. In such a case it is out of the question to attribute the child's intelligence to special opportunities provided by his home or family.

To secure cases in which children's genetic endowment is the same, the psychologist turns to assessments obtained from monozygotic or identical twins. In Britain nearly thirty pairs have been investigated where the twins have been brought up in separate homes almost from birth. The correlations are, for educational attainments, 0·68; for group tests of intelligence, 0·77; for adjusted assessments of intelligence, 0·88—almost as high as the correlation between two successive assessments for the same child.

Hitherto those psychologists who have admitted the possibility that mental abilities may be inherited have almost invariably assumed that their transmission would follow the principles of blended inheritance. They repeat the old definition of heredity as 'the tendency of like to beget like'; and consequently suppose that the arguments for mental inheritance consist solely in demonstrating resemblances between the parent and his children by means of correlations; when the two parents differ, then the child is still expected to consist of an intermediate blend of both.

The approach of the modern geneticist is the reverse of all this. As he views it, the real problem is rather to explain why in so many instances 'like begets unlike'. Both for the environmentalist and for the believer in blended inheritance, one of the most puzzling phenomena is the appearance, not only of extremely dull children in the families of the well-to-do professional classes, but also of extremely bright children in families where the personal, cultural and economic conditions of the parents would, one might imagine, condemn every child to failure on either count. On the Mendelian hypothesis that is just what we should expect. After all, Mendel himself suggested the possibility that the inheritance of graded characteristics might be interpreted in terms of a multifactorial hypothesis; and during recent years a vast and valuable amount of work among plants and animals has been done by the biometric school, in which that hypothesis has not only been fully confirmed but also has issued in results of the greatest practical value.

In point of fact several investigations recently published yield fairly clear indications that in the case of intelligence individual variations are influenced by both unifactor and multifactor inheritance; in other words, they result from Mendelian factors of two kinds: (1) major genes responsible for comparatively *large* deviations, usually of an abnormal kind; and (2) multiple genes the effects of which are *small*, *similar* and *cumulative*. The biometric techniques have been elaborated by R. A. Fisher and others; and on applying their procedures it is found that, with the ordinary tests of intelligence, about three-quarters of the total variance is due to genetic factors, that is, to what is loosely called heredity. If the results of the tests are corrected and adjusted in the light of all available information, then the accuracy of the predictions is greatly improved. In practice, such intensive studies of individual cases would be far too costly for education authorities to carry out, except perhaps in borderline cases[6].

Investigations made just before the War showed that during the ten preceding years about 40 per cent of those who had sufficient ability to enter a university had apparently failed to do so[7]. It is too early to inquire what improvement has been effected

by improved economic conditions or by the new arrangements made under the Education Act of 1944. A series of studies recently published by Dr. Floud[8] and her colleagues shows that the grosser material handicaps appear to have been lessened and in many areas eliminated, but that the problem of social wastage is as yet by no means overcome.

The whole issue is of such far-reaching social importance that there is a most urgent need for more research. Since school investigations undertaken by outsiders are bound to be incomplete, it is to be hoped that once again the more progressive local education authorities will allow their official psychologists time and full facilities for such inquiries. But the underlying processes are so complex and obscure that the psychogenetics of man is not likely to make much headway without carefully controlled experiments on the nature and transmission of intelligence in lower animals.

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COLONIAL RESEARCH

1955–56

UNDER the title "Colonial Research 1955–56"* are collected the annual report of the Colonial Research Council, the eleventh annual reports of the Committee for Colonial Agricultural, Animal Health and Forestry Research and the Colonial Medical Research Committee, the ninth annual reports of the Colonial Economic Research Committee and the Colonial Committee for Pesticides Research (formerly the Colonial Insecticides, Fungicides and Herbicides Committee), the third annual report of the Colonial Products Council, the twelfth annual report of the Colonial Social Science Research Council, the first annual report of the Colonial Road Research Committee, the annual report of the Colonial Fisheries Advisory Committee on Fisheries Research, 1955–56, and the reports for 1955–56 of the Tsetse Fly Trypanosomiasis Committee and of the Director of the Anti-Locust Research Centre. There is also a section on research matters not covered by the reports of the specialist advisory bodies, which deals with building and housing research, the Falkland Islands Dependencies Survey, geodetic and topographic surveys, geological surveys (for which a further allocation of £1,250,000 has been made available to March 31, 1960, under the Colonial Development and Welfare Act, 1955, and whose staff of 205 geologists, geophysicists and chemists in twenty-one territories receives valuable assistance from the universities of the United Kingdom and other members of the Commonwealth), the East African Industrial Research Board, meteorology and water pollution research.

The annual report of the Colonial Research Council, to which is appended a list of schemes approved for research grants under the Colonial Development and Welfare Acts, April 1, 1955, to March 31, 1956, deals with matters not covered by the reports of the specialist committees. It notes that the expenditure on research schemes for the year ended March 31, 1956, was £1,364,320, compared with £1,173,381 the previous year and the average of £1,600,000 called for by the provision for 1955–60, and that 39 new appointments were made to the Research Branch during the year; but it does not supply the conspectus of the whole field that now seems desirable. Besides lists of publications during the year, the various reports are now provided with a full list of contents.

The Committee for Colonial Agricultural, Animal Health and Forestry Research, which recommended grants for research totalling £819,495 during the year, is much exercised by the difficulty of finding and retaining good research scientists in overseas posts. Serious losses of young scientists with two to six years overseas experience continue. In September 1955 the three research schemes at the Imperial College of Tropical Agriculture, Trinidad, for work on cocoa, bananas and soils were combined and a Regional Research Centre was created under the Principal of the College as director of research. This Centre will in future embrace all appropriate fields of research. The West African Standing Advisory Committee for Agricultural Research has been established and met for the first time. Cocoa research, carried out chiefly at the West African Cacao Research Institute and the Imperial College of Tropical Agriculture, confirmed the close dependence of mineral nutrient uptake on the degree of shade, and demonstrated the connexion between the nitrogen status of a plant and its liability to attack by thrips. In West Africa, important information was gained on the tolerance of certain Iquitos strains of cacao to swollen shoot viruses, and preliminary tests indicated that BHC has a higher toxicity for capsids than DDT.

The South American maize rust disease which has caused much concern in the hot, humid parts of Africa continued to spread eastwards, being reported from Malaya, North Borneo, Siam and intervening islands in the Indian Ocean. Resistant varieties are being issued to growers in West Africa, where research is now directed to breeding for resistance to other pests and diseases. In the early stages of investigations in Kenya on coffee berry disease, the mercurial fungicide 'Verdasan' showed promise as a possible means of control. A pool of research workers on stored products has been established, based at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, and the Stored Products Research Sub-Committee was specially concerned with co-ordinating the work of the West African Stored Products Research Unit, the code of

* Colonial Office. Colonial Research 1955–1956. Pp. 312. (Cmnd. 52.) (London: H.M. Stationery Office, 1957.) 10s. net.

practice in the use of BHC and DDT, with the control of insect pests of groundnuts in the Gambia—where infestation of unshelled groundnuts by *Caryedon fuscus* can be reduced to a negligible level by application of 5 per cent of DDT or 1 per cent of 'Lindane' within the prescribed health limitations—and the use of insecticides on stored cocoa in West Africa. Veterinary investigations relate largely to the testing of biological preparations and other drugs and to the detailed study of well-known diseases in relation to local conditions and breeds of cattle. In East Africa outstanding findings relate to the considerable resistance to East Coast fever which exists in zebu animals from immune stock; this resistance decreases with age, and colostral immunity plays little or no part in it. It is established that a solid immunity for at least a year follows recovery from an attack of East Coast fever, and that the fever may be suppressed by continuous oral administration of 'Aurofac', a by-product of the manufacture of aureomycin. It has also been observed that calves born of dams immune to rinderpest are susceptible before suckling but develop immunity one to two days after suckling; however, this colostral immunity declines fairly rapidly, disappearing in about six months. Use of 'Antrycide' has permitted large numbers of cattle to be held in areas of Kenya infested with tsetse fly, with low rates of infection by sleeping sickness.

At the Malayan Forest Research Institute excellent hardboards have been produced from mixtures of common Malayan woods and high-quality paper from pedi straw. Trials with tropical pines in the Caribbean have demonstrated the importance of small doses of phosphatic fertilizers in the early stages of growth, the response of the trees being remarkable in some cases. Much help was given to the Committee by research institutions in the United Kingdom, particularly the Agricultural Research Council and the Experimental Stations under its control. The Rothamsted Experimental Station, for example, completed a final comprehensive report on "The Responses of Sugar Cane to Fertilizers".

The Colonial Economic Research Committee's report is the briefest of the twelve. It records the completion of Prof. Gilbert Walker's monograph, "Nigerian Transport in 1950", and of Mr. G. A. Petch's report on the agricultural economy of Sierra Leone with special reference to the oil palm industry. Dr. A. R. Prest's fiscal survey of the British Caribbean is being prepared for publication in the Colonial Research Studies series, in which Mr. F. H. H. King's "Money in British East Africa" will also appear. Mr. D. T. Edwards, attached to the Institute of Social and Economic Research in the University College of the West Indies, is now completing the analysis of the economics of small farms in Jamaica, carried out in close association with the Jamaican Department of Agriculture; and work has been started on the national income inquiry in Tanganyika. The Royal University of Malta and the Durham Colleges are making a joint investigation into the agricultural economy of Malta. A grant of more than £16,500 was made to Makerere College to enable the East African Institute of Social Research to continue its work on industrial and labour economics in East Africa and to expand along lines suggested by the East Africa Royal Commission. The Economic Research Unit of the University College of the Gold Coast undertook an investigation into the problems of food supplies to the Sekondi–Takoradi area and neighbouring urban districts, to facilitate formulation of a feeder-road policy. The Scientific Council for Africa South of the Sahara is convening a meeting of economists in Nairobi to discuss the preparation and regular issue of a register of economic research in tropical Africa.

The annual report on fisheries research for 1955–56 comprises the reports of the individual Colonial fisheries research stations. The work of the Inter-Territorial Fisheries Research Station at Jinja on Lake Victoria shows how the study of fisheries and of fish draws in as essential corollaries studies of the water they inhabit, of the bacteria and plants present in the water, of the soil and its chemical constituents and bacteria, and of the invertebrates, especially insects, which are probably the most important food of the fish in the Lake. While the content of biologically valuable electrolytes in the lakes of East Africa is much lower than might at first appear, plant nutrients occur in vast quantities in the deposits of organic matter on the lake bottom, and dried samples of this mud appear to offer potential supplements to the food of cattle, pigs and chickens, and the fertility of the lake would be increased if ways could be found to accelerate the decomposition of these deposits *in situ*. The research station now has a wide entomological programme. The East African Marine Fisheries Organization continues to study the big pelagic fishes of the western Indian Ocean, the principal bottom fishes (snappers and groupers), the oceanic circulation and variations in the layering of the waters with the changes of the monsoon. A study of the plankton has been undertaken, with a view of throwing light on the movement of the big pelagic fishes.

The Joint Northern Rhodesia–Nyasaland Freshwater Research Station started work at its new permanent headquarters at Samfya on Lake Bangweolo, but most of the year was devoted to a general survey of Lake Nyasa from an ecological point of view, with a more detailed study along the same lines of the lake littoral, and also of the Utaka, a group of species of cichlid fishes, which are one of the most important economic groups of the deep and rocky Northern Lake. At the West African Fisheries Research Institute important work has been done on the invertebrate bottom-fauna, the first results of which indicate that the biomass of the Sierra Leone benthos is considerably lower than that of comparable communities in European waters. The routine plankton survey of the Sierra Leone River estuary is nearing completion. At the Singapore Regional Fisheries Research Station the work on prawns, begun in the Singapore prawn ponds, has been extended into offshore waters and includes determination of the variety and distribution of species of Malayan Penacid prawns, identification of the more important economic species in the Singapore prawn ponds and in the fisheries of the Federation of Malaya, a study of the biological and other factors influencing them and an analysis of factors with a view of improving fishing techniques. Plankton research and hydrological investigations continued in the Singapore Straits. Construction of the Fish Culture Research Station, Batu Berendam, Malacca, is well advanced, and the Fisheries Research Unit in the University of Hong Kong continued routine hydrographic observations in waters around Hong Kong and obtained some promising results in research on the oyster fishery in Deep Bay.

The eleventh annual report of the Colonial Medical Research Committee pays tribute to the services of Prof. P. A. Buxton, whose death was a grievous loss to the Committee. The digression into the field of the sickle-cell trait and sickle-cell anæmia noted last year has been continued, and the research on tuberculosis has now been extended to West Africa. Plans have matured for a research unit in West Africa on onchocerciasis under the scientific supervision of the West African Council, and two young zoologists are being recruited for comprehensive basic training in the malacological aspects of schistosomiasis before embarking on field investigations. A Leprosy Sub-Committee has been appointed which has appointed a Laboratory Panel, both bodies comprising scientists whose investigations can contribute to the elucidation of problems confronting leprologists in chemotherapy, epidemiology, tissue culture, morbid histology, electron microscopy, immunology, bacterial resistance, etc., and five grants were made for leprosy research to aid investigators, both abroad and in British universities. A substantial grant was contributed towards a concerted research project to be initiated in Jordan, where a Trachoma Research Institute will be built and associated with a new ophthalmic hospital serving the large number of 'displaced persons' in that region among whom the disease is rife. The unit will be closely associated with virologists at the Institute of Ophthalmology, London, and the Lister Institute.

Laboratory studies on the effect of insecticides on *Chrysops* larvæ kept in trays full of mud indicate that both dieldrin granules and 5 per cent DDT emulsions will kill the larvæ, but at very high concentrations. A pilot scheme for the eradication of Bancroftian filariasis with diethylcarbamazine was initiated on Ukara Island in Lake Victoria; in Malaya administration of about six weekly or monthly doses each of 5 mgm./kgm. of diethylcarbamazine citrate has been found to give promising results in the mass treatment of populations affected with *Wuchereria malayi*. Investigations on guinea-worm at University College, Ibadan, were largely concerned with the location of the parasite within the body during the first two months after being fed to puppies. A comprehensive examination has been made of the anophelines in the Pare lowlands, East Africa, to establish a base-line from which the effect of residual house-spraying can be measured, and the degree of malarial infection in man over the whole area has been measured. The Malaria Control Pilot Project in Western Sokoto, Northern Nigeria, found a median lethal concentration for dieldrin of at least 2 per cent, in contrast with 0·25 per cent for *A. gambiae* from a Lagos colony or from unsprayed areas in Western Sokoto. Whereas malaria declined in the first half of the year, the decline was not maintained, especially toward the end of the rainy season. Epidemiological studies on yellow fever and the antigenically related but relatively innocuous virus, Uganda *S*, Zika and West Nile, have revealed problems of great complexity, while at the East African Virus Research Institute at Entebbe, Uganda, systematic studies on cycles of Rift Valley fever virus multiplication in the mouse and the pathogenic effects of the virus on the host were concluded.

The research project for the study of viruses in man, animals and arthropods in the Caribbean region had another most successful year, and a further extensive investigation is in progress at the University of Malaya to establish the position of poliomyelitis in Malaya. A comprehensive study of the feeding habits of tsetse flies indicated no significant variations in the feeding habits of *G. morsitans* and *G. swynnertoni* in ten different areas from which the blood-meals were obtained. In Tanganyika a unit detached from the Research Institute at Mwanza made a six months diet survey in the Taveta–Pare area as a contribution to the physiological assessment of the effects on the population of the attempted mitigation of malaria by residual house-spraying with dieldrin. At the Hot Climate Physiological Research Unit in Nigeria, studies of the effect of wind on reaction to heat and on sweat-gland fatigue continued, and the effect of climate on the performance of minor skilled tasks and the use of groundnut flour in human nutrition were also examined. The Tropical Metabolism Research Unit, Jamaica, continued its work on the gross composition of the tissues in malnutrition, and new evidence was obtained at the University College of the West Indies on why a fall in liver glycogen, now considered responsible for the 'vomiting sickness' of Jamaica, follows the administration of hypoglycin. The three main lines of research pursued on sickle-cell trait and sickle-cell anæmia were the chemistry of sickling; the conditions under which susceptible cells become sickled; and the genetics of hæmoglobin types. Therapeutic studies on leprosy in Nigeria have shown 'Avlosulfon Soluble' to be a suitable and convenient preparation for administration by injection, and diphenylthiourea has also given promising results in treating leprosy.

The ninth annual report of the Colonial Pesticides Research Committee refers to the disbanding of the Herbicides and Arboricides Sub-Committee and the formation of a new sub-committee on methods of application which will include in its terms of reference the application of liquid sprays, dusts, dispersible powders, aerosols, mists and fogs from the ground and from the air, incorporating the work formerly undertaken by the Aircraft Trials Sub-Committee. Arusha is being made the main centre for overseas Colonial Pesticides Research activity, by amalgamation of the Unit lately at Ilanga and by the later inclusion of other detached units. Work at Arusha has continued in an effort to establish the optimum conditions under which tsetse fly and mosquitoes may be killed, the Physics Section has devised a suitable installation for disseminating granular insecticides containing dieldrin by aircraft, and ground spraying experiments with arboricides and herbicides continued. The Biting Fly survey work in Uganda, the survey of filariasis vectors in Fiji and the Western Sokoto Malaria Control Pilot project also continued. The persistence of DDT, dieldrin and BHC water-dispersible powders on mud walls is found to be characterized by a rapid loss from the surface half-millimetre during the first two weeks after spraying. This loss of DDT and dieldrin is due primarily to diffusion into the wall and consequent inactivation biologically. Research into the control of *Pseudotheraptus wayi*, the chief cause of fall of coconuts in Zanzibar, continued.

At the Colonial Insecticide Research Unit, Porton, work on the sorption of insecticides by soils indicated that the rate of disappearance of insecticides from the sprayed surface of mud blocks is inversely proportional to the humidity; but once absorbed, the rate of diffusion of insecticide away from the surface is directly proportional to humidity, increased humidity enhancing the mobility of adsorbed insecticide. Work on residual deposits on vegetables

proceeded, while that on the crystallization of insecticides from urea-formaldehyde resin films was completed. Studies of the cumulative effect of sub-lethal doses of insecticides suggest that house-flies can eliminate, metabolize or store in a harmless condition, depending on the insecticide, a proportion of that absorbed, providing the dosage is sufficiently low. Studies on olfactory stimulation of tsetse flies, on the pick-up of insecticides from surface deposits, and on the penetration of the insect integument by insecticides at the Imperial College Field Station, Silwood Park, continued, as well as the work at Rothamsted Experimental Station on the toxicity of DDT emulsion films and the persistence of DDT on foliage, and on the evaluation of new chemicals for controlling undesirable vegetation at the Agricultural Research Unit of Experimental Agronomy, Oxford. Attention is also directed to research being done in the Colonies without the assistance of the Committee.

The third annual report of the Colonial Products Council covers both the work of the Colonial Products Laboratory and research and development elsewhere carried out under the direction or with the assistance of the Council. Under an expanded programme of research on pyrethrum, to be co-ordinated by the newly-formed Pyrethrum Research Committee (United Kingdom) in close liaison with a corresponding committee in East Africa, fundamental chemical investigations are to be made by the Colonial Products Laboratory and concomitant biological studies by the Rothamsted Experimental Station. The Laboratory handled 810 inquiries during the year, covering such products as essential oils, spices, copra, maize, sorghum, cassava starch, pineapples, citrus fruits, coir, hemp, paper-making materials, hides and wattle. The eighty investigations completed included examinations of sawdust and sawmill waste of slash pine from British Honduras; Cyprus sage oil; vetiver oil from British Guiana; ylang-ylang oil from Zanzibar; cedarwood sawdust and oil from Kenya; *Aleurites montana* oil from Nyasaland; shea nut butter from West Africa; arrowroot starch from Antigua and Montserrat; kenaf fibre as a jute substitute, and grasses and reeds from Northern Rhodesia as paper-making materials.

Experiments on controlled curing of cacao beans in 'micro-fermentaries' continued at the Colonial Microbiological Research Institute, Trinidad, where the action of polyphenol oxidase on catechol is also being examined and several high-yielding strains of *Aspergillus terreus* have been found for production of itaconic acid from molasses. The Sugar Technological Laboratory, Trinidad, continued investigations into the effect of drought on the properties of sugar cane juice. At the Forest Products Research Laboratory, Princes Risborough, satisfactory water resistance in boards from dense hardwoods, such as morabukea from British Guiana, was achieved without loss of strength by applying drying oils to the boards after pressing, followed by heat treatment, or by adding wax emulsion and synthetic resin to the pulp. At the University College of the West Indies conditions for growing the organisms producing monamycin in deep culture have been defined, studies on non-specific acetylcholine antagonism at the Department of Pharmacology, University of Birmingham, were extended, and the structure of the two ketones obtained from cork has been elucidated at the Royal College of Science and Technology, Glasgow.

The first annual report of the Committee on Colonial Road Research notes that the Committee at its first meeting in June 1955 agreed on programmes of research concerned with pavement design; drainage, erosion and moisture movement; bituminous surfacings; and machinery and labour problems. The Committee stresses the importance of an adequate number of materials engineers if the full benefits of research are to be obtained. Data collected by the Air Ministry on the movement and distribution of moisture in soils under airfields in tropical and sub-tropical areas are being analysed at the Road Research Laboratory, where a method developed for forecasting moisture conditions under pavements in Great Britain is the starting-point of an investigation to provide a corresponding method applicable in other climates.

To the twelfth annual report of the Colonial Social Science Research Council are appended reports for 1955–56 from the East African Institute of Social Research, the West African Institute of Social and Economic Research now being wound up (to be replaced in Ghana by the recently formed Economic Research Unit), the Institute of Social and Economic Research, University College of the West Indies, the Rhodes–Livingstone Institute, the Educational Research Institute for Fiji and Western Pacific Territories and the Social Research Unit, University of Malaya. The most important new grants during the year were to Makerere College for the continuation of the East African Institute of Social Research (£82,329); the Government of Northern Rhodesia for the central office and headquarters expenditure of the Rhodes–Livingstone Institute (£32,770); University College, Ibadan, for the Department of History's Benim project (£20,000); for the maintenance for a further year of the West African Institute of Social and Economic Research (£7,483); a contribution towards a study of family attitudes in Jamaica undertaken by the Conservation Foundation (£7,000); and to the Swaziland Government for a study of land tenure and land use (£6,875). A third volume, on "The Non-Bantu Languages of North-east Africa", in the Handbook of African Languages of the International African Institute is in the press, and the Linguistic Survey of the Northern Bantu borderland, in which the Governments of Belgium, France, Nigeria and the Anglo-Egyptian Sudan also co-operated, is being published in four volumes, of which Volume 1 has already appeared and Volumes 2 and 4 are in the press.

The report of the Tsetse Fly and Trypanosomiasis Committee for the year ended March 31, 1956, stresses the prospect of advances in the control of trypanosomiasis in domestic animals offered by the advent of a number of new trypanocidal drugs, trials of which in Africa were arranged. The Committee concluded that an important new phase had been reached in the control of bovine trypanosomiasis and recommended a conference of veterinarians from African administrations to stimulate progress and concerted effort. Present policy in tsetse research in East Africa gives priority to research on behaviour and physiology of *Glossina*, with an emphasis on laboratory studies; while at the West African Institute for Trypanosomiasis Research studies have been made on the mechanism of acquired drug resistance, using four syringe-passaged strains of *T. rhodesiense*, three of which had been made resistant to

'Melarsen', 'Stilbamidine' and 'Butarsen', respectively. Experiments were also started on the possibility of forming suramin complexes with veterinary trypanocidal drugs, and basic research continued into the optimal conditions for rearing *G. palpalis* in the laboratory. In Northern Rhodesia studies were made of cross-resistance to drugs in trypanosomes occurring in cases treated with 'Dimidium', 'Ethidium' and 'Antryeide', and of the control of tsetses with insecticidal sprays, while in Uganda the Tsetse Control Department has obtained promising results in preliminary trials of 'Arkotine' for control of *G. palpalis*.

The report for 1955–56 on locust research and control of the Director of the Anti-Locust Research Centre, which received 1,171 reports from 42 territories in 1955, records further progress in the analysis of the seasonal development of desert locust plagues, and in the re-examination, in the light of recent information on swarm movements and behaviour, of the historical data on the inter-plague periods. The results suggest the possibility that some swarming populations occurring within the desert locust distribution area during the inter-plague periods may sometimes play an important part in the recrudescence of the plagues. In the locust laboratory the main emphasis has been on breeding *Schistocerca*. The Desert Locust Survey continued intensive investigations on the assessment and improvement of control methods, particularly aircraft spraying.

OBITUARIES

Dr. G. B. Jeffery, F.R.S.

George Barker Jeffery, director of the Institute of Education, University of London, who died on April 27, was born on May 9, 1891. He was educated at Wilson's Grammar School and went from there in 1909 to University College, London, where he rapidly made his reputation as a mathematician. He was appointed reader in mathematics in 1921 and Astor professor of mathematics in 1924; he was elected a Fellow of University College in 1916 and a Fellow of the Royal Society in 1926.

As this record implies, Jeffery's original work in mathematics began early (his first paper was read before the Royal Society in the month following his twenty-first birthday) and was distinguished. He covered a wide field in which the main subjects were the theory of relativity and (over a longer period) hydrodynamics and elasticity together with the theory of the relevant differential equations. His sustained interest in pure mathematics was evident, but the usual classification would assign most of his published work to applied mathematics. Much of his work was, however, concerned with exact solutions, and so was of particular value in fields where such solutions are rare and some form of approximation must often be accepted.

An inspiring teacher himself, Jeffery was interested in teaching in schools as well as in universities, in teaching overseas as well as at home; this determined his choice of subject in various public addresses. In his presidential address to the London Mathematical Society (1937) his subject was the study of mathematics in modern universities. He said then that, if asked to say why he thought his own subject important, he might reply that "pure mathematics is a good subject because I like it", and suggested that all the implications of this answer should be fully thought out. In his presidential address in 1948 to the Mathematical Association on "Mathematics as an Educational Experience", he was concerned to defend mathematics as a school subject from "attack by the anti-intellectual forces that are rampant in our national educational thought". The imperfections in examinations were admitted, but "it would be idle to deny the stern discipline they effect by discriminating between sound knowledge and verbiage and between conscientious preparation and slacking".

It is perhaps natural that Jeffery, whose interests in mathematics were so wide, should have had wide interests outside, but it is astonishing that he should have found so much time and energy to devote to them. He was a skilled cabinet-maker, and excellent examples of his craft adorn University College, and no doubt other institutions with which he was concerned, and in later years he became a proficient silversmith. Since 1952 he had been dean of the College of Handicraft, and tribute has been paid to his enthusiasm by the master of the College, Mr. R. A. Butler.

In 1939 Jeffery acted as pro-provost for the section of University College that went to Bangor. He was occupied there with the difficult administrative problems of the war years as they affected the College and the University—and took part when occasion required in the rescue of parties of students in difficulties on Snowdon. He was appointed director of the Institute of Education shortly after the return in December 1944 of University College to London.

W. R. Dean

Dr. G. B. Jeffery first came into contact with the study of education and with the training of teachers when he was himself a student in 1911–12 at the old London Day Training College. It was there that he met his future wife; and it was there that he came under the influence of that great educator, Sir Percy Nunn. From the latter he acquired not only a deep interest in the philosophy of science and in the theory of education, but also an abiding faith in education as an instrument for social advance.

During the 'thirties, Prof. Jeffery was examiner in mathematics for several of the training colleges already associated with the University of London through the old Training Colleges Delegacy. Inevitably, his wisdom and his administrative gifts brought him into close contact with the running of that Delegacy: his counsel and advice were sought continually. Thus, when it became necessary, in 1945, to work out the institutional mechanism needed to implement the McNair Report, it was to Jeffery that everyone turned. It was he who, more than anyone else, was responsible for drawing up a constitution and a set of regulations which are the charter of the London Area Training Organization.

When Sir Fred Clarke retired, it seemed proper and natural that Dr. Jeffery should be offered the directorship of the enlarged Institute which he had himself done so much to create. The duties of the double post, which he discharged with admirable unselfishness for more than ten years, were in fact heavier than any one man should be asked to tackle. He was the administrative and academic head of an Institute which grew to more than 1,200 students. When he began, the Institute had two chairs and two readerships. Now it has five chairs and four readerships. But, in fact, these numerical data give only an abstract and empty notion of the complexity and importance of the work done under his guidance and inspiration. In addition to this, Dr. Jeffery was also head of a federation of thirty-eight colleges and departments spread over the whole of the south-east England and responsible in the aggregate for the training of nearly one-third of the teachers of England. At the cost of heavy and unremitting work he managed to inject vigour, vitality and purpose into the complex organization of committees, panels and examinations boards through which the federation operates. Not content with this, he found the time and energy needed to set going an ambitious and quickly growing organization serving the teachers of London through the provision of part-time and evening courses, conferences, and so on. Nor should one forget that it was he who was chiefly instrumental in providing for the Institute five hostels in which students of all nationalities and races live and study together.

The Institute of Education in London is the largest institution of its kind in the British Commonwealth. It has a high and well-deserved international reputation, not only as an institution for the training of teachers, but also as a centre of research which draws students from the whole world. That it should flourish so vigorously is a monument to G. B. Jeffery —and the best, perhaps the only one, that he would have wished for. He has earned the respect and gratitude of all who care for the improvement of educational thought and practice as well as the admiration and affection of his colleagues.

J. A. Lauwerys

Dr. A. J. G. Barnett

Adam John Guilbert Barnett, who died suddenly in St. Andrews on June 6, was educated in the University of Edinburgh, where he took the degree of B.Sc. in 1930. After working with Dr. H. G. Rule on the activity of halogen atoms in substituted naphthoic acids, he obtained his Ph.D. in 1932. In the same year he was appointed to the Colonial Educational Service as a lecturer in the Higher College, Yaba, Lagos, and for the following decade was occupied with teaching and research. At the beginning of the Second World War he volunteered for service in the Royal West African Frontier Force. In 1942 he was appointed Deputy-Controller of Transport for Nigeria.

The strain to which his war service subjected him precipitated a serious illness and resulted in his premature retirement from the Colonial Service. He had developed an interest in the application of chemistry to agriculture and, after recuperation over a couple of years in the quietude of Glen Livet, he was appointed to a post in the North of Scotland College of Agriculture. In 1949 he joined the staff of the University of Aberdeen, in charge of agricultural biochemistry within the recently established Department of Biological Chemistry. During the next few years, Dr. Barnett rapidly established himself as an authority on the chemistry and biochemistry of silage production. He and his students produced numerous papers on various aspects of this important agricultural process, and in 1954 he published a book on silage fermentation which has obtained wide recognition as a valuable and original contribution to the literature of the subject. More recently, he has studied certain problems of ruminant digestion and has published a number of papers embodying his results.

Dr. Barnett was a man of many interests outside the narrower field of scientific endeavour. This wider and humane outlook undoubtedly contributed to his success as a teacher. He had a kindly interest in his fellow-men, but especially in his students, both undergraduate and postgraduate. At the same time, he had a high standard of efficiency which he applied both to himself and to those associated with him, and he was not disposed to suffer fools gladly. He participated actively in the affairs of the British Legion (Scotland) and when he died he was actually at the annual conference in his capacity as president of the Aberdeen Branch. Dr. Barnett, who was forty-eight years of age, is survived by his widow and two sons.

W. O. Kermack

Mr. G. H. S. Wood

Mr. G. H. S. Wood, who lost his life on May 5 as a result of burns sustained in an accident when camping in Brunei, was one of the small number of men with a good training in botany who have afterwards turned their attention to forestry. After graduating at Oxford in 1948, he was appointed to the Colonial Forest Service and posted to Uganda, but later transferred to the Colonial Research Service as forest botanist. He was then posted to North Borneo, where at the time of his death he was engaged in systematic collection of herbarium material and in ecological studies, especially on the Dipterocarpaceae which form so important a part of the flora of the region. His material has been distributed to several of the leading herbaria, and is of particular value through being linked with timber samples used for anatomical study and for laboratory testing of physical properties; it was further supplemented by many photographic records. He also made valuable collections of Bryophyta in both East Africa and North Borneo.

Wood was a man of wide interests and great activity, being equally at home on a mountain (Ruwenzori, Elgon, Kilimanjaro, Kimbalu, etc.), on the water, and in the air, and he never missed an opportunity of travel. The tragic accident of his death has terminated a most promising career which had already reached the productive phase.

H. G. Champion

Mr. L. C. E. Bushby

Leonard Charles Edwin Bushby died suddenly at Rye on May 2 as a result of an accident. He was sixty-one years of age.

After leaving school, he started work at a bank, but was old enough to join the Army for the last year of the First World War. On demobilization, he followed his natural inclination and took a course in entomology at the Imperial College of Science and

Technology, London. Soon after the completion of this he followed Miss E. Cheeseman as curator of insects at the London Zoo. He worked there until his retirement in 1955 at the age of sixty. He acquired a bungalow at Challock Lees, near Ashford, Kent, in the centre of much interesting and varied country.

The first year of his retirement was clouded by the illness and death of his great friend, Jack Lester, who was curator of reptiles at the Zoo.

Leonard Bushby was an enthusiastic field naturalist. A great lover of wild life in the country, his knowledge was wide rather than deep and specialized. Insects were his principal study. The Coleoptera, of which he amassed a good collection, came first—but he was also greatly interested in Lepidoptera, Neuroptera and Homoptera and other orders. He was an active member of the newly formed Kent Field Club and acted as honorary secretary to the Entomological Section of the Folkestone Natural History Society.

A lovable personality, he is greatly missed by many friends. He was never married. E. SCOTT

NEWS and VIEWS

Research in Physical Metallurgy at Birmingham: Prof. A. D. McQuillan

PROF. A. D. McQUILLAN, recently elected to the research chair in the Department of Physical Metallurgy at the University of Birmingham, was formerly a scholar of the University of Durham, where he obtained first-class honours in physics. During 1942–45 he was a member of staff of the Royal Aircraft Establishment, Farnborough, first in the Radio Department, but latterly in the Metallurgy Department. His work there on the development of high-temperature materials for application to jet aircraft engines stimulated his interest in the physical nature of transition metals. After two post-war years with the Research Laboratories of the Mond Nickel Company, Dr. McQuillan went to the Baillieu Laboratory of the University of Melbourne as a senior member of a research group established for the study of the physical metallurgy of titanium, with particular reference to its electronic structure. On his return to Britain in 1951, Dr. McQuillan continued his work on titanium as the leader of a research group established in the Physical Metallurgy Department at Birmingham under the general direction of Prof. G. V. Raynor, and is the author of numerous papers describing the results of this work. With his wife, Mrs. M. K. McQuillan, he is the author of a book on titanium, and has lectured in America and Europe. Dr. McQuillan's appointment marks the stage at which the scope of the work at Birmingham is to be widened to include studies of the theory of alloying for other early transition metals, which are of importance in nuclear engineering.

Economics at the University of Sheffield: Prof. J. C. Gilbert

MR. J. C. GILBERT, at present reader in economics in the University of Sheffield, has been appointed to the chair of economics at that University in succession to Prof. G. P. Jones, who retires at the end of September. Mr. Gilbert has also been appointed head of the Department of Economics. Mr. Gilbert was a student of the London School of Economics when he graduated in 1929. In 1927 he was awarded a Sir Ernest Cassel Travelling Scholarship, which he held at the Handels-Hochschule, Berlin. In 1929 he was appointed an assistant on the teaching staff of the London School of Economics and in 1931 to a lectureship in economics at the School of Economics, Dundee. During the War, Mr. Gilbert worked in the Home Timber Production Department of the Ministry of Supply. In 1945 he was appointed lecturer in economics in the University of Manchester, going to Sheffield in 1948, since when he has been successively senior lecturer and reader. In 1956 Mr. Gilbert visited Germany to give a series of lectures on behalf of the Foreign Office. He has published many articles on economic theory and is a member of the editorial board of the *Yorkshire Bulletin of Economics and Social Research*.

Prof. D. C. Hague

MR. D. C. HAGUE, at present reader in political economy in University College, London, has been appointed to the newly created Newton Chambers chair of economics at the University of Sheffield. Mr. Hague graduated at the University of Birmingham in 1946, and in 1947 became assistant lecturer in political economy at University College, London, since when he has been appointed lecturer and recently reader in political economy. Mr. Hague has published a number of articles on economic subjects and is joint author of two books. His book, "The Economics of Man-made Fibres", has recently been published. Since 1953 Mr. Hague has been *rapporteur* to the International Economic Association.

First World Meteorological Interval

THE ten-day period June 20–29, which includes the summer solstice, was designated a World Meteorological Interval, and will be followed during the International Geophysical Year (which begins on July 1, 1957, and will continue until December 31, 1958) by six similar Intervals, three months apart, each including the time of an equinox or of a solstice. During the first World Meteorological Interval, and in the following ones, an intensified effort is called for at the permanent aerological stations of the world, and those which have been specially established for the International Geophysical Year, to make combined temperature, humidity and wind soundings four times daily (at 0, 6, 12, 18 G.M.T.); and, by using larger balloons, to achieve measurements to greater heights than are normally attained, namely, to at least 20 miles whenever practicable. This extended programme will be undertaken at three of the Meteorological Office upper-air stations in the United Kingdom and by British Ocean Weather Ships in the North Atlantic; and, slightly less completely, at aerological stations operated by the United Kingdom at seven bases on the Mediterranean and in the Middle East.

Science in the Durham Colleges

The Durham Colleges division of the University of Durham is launching an appeal for £250,000 towards its development programme, the primary object of which is to raise the numbers of its undergraduate and postgraduate students in science from 400 to 1,000, within the framework of an expansion of the total student body to 2,000. The erection of a new building to house the departments of chemistry and geology is to commence in 1958; this will permit additional space to be allocated to physics, botany and zoology. In 1959 it is proposed to begin work on a school of applied physics, the first subject within the Faculty of Applied Science to be taught in the division. It is hoped that the building will form the first unit of a much larger physics department. To accommodate the students, 700 extra residential places are required, and during 1957 a new men's college, the eleventh of Durham's colleges and societies, is to be founded.

Particular emphasis is placed upon the research needs of the pure science departments, and funds are to be allocated for the further development of nuclear research, both physical and radiochemical, and for the completion of laboratories for geophysics and geochemistry. A generous donation of £50,000 has already been received from the Sir James Knott Trustees towards research in physics. In the quiet atmosphere of a small university and cathedral city, Durham has ample space in which to expand its facilities for both teaching and residence. But it cannot achieve its full objects without private support as well as government backing.

British Museum (Natural History)

A device to show some aspects of natural history by means of coloured stereoscopic photographs has recently been completed in the central hall of the British Museum (Natural History). Stereo-pairs of photographs are projected on a 3-ft. screen to be viewed through five polarizing windows. A sequence of twelve scenes is shown automatically, but for special demonstrations a lecturer can exercise independent manual control and a larger audience using polarizing spectacles can be accommodated. Coloured stereo-photographs of some of the sea birds now nesting on Anglesey and on the uninhabited island of Priestholm (north-east of Anglesey) have been taken by the Museum photographic staff, and the first set is now on view. The photographs will be changed at fairly frequent intervals, and other aspects of natural history will be illustrated later. It is hoped that the apparatus will supplement the specimens on view in the galleries by providing vivid impressions of habitats, breeding cycles and other activities of many different groups of animals.

Among the more important recent acquisitions of the British Museum (Natural History) is the collection of the late Mr. A. G. Davis, who died in March, consisting of more than 200,000 fossil specimens, mainly invertebrates from the Lower Tertiary and Quaternary deposits of southern England, all collected with precision and very fully documented. Among them are numerous choice specimens, and many are from localities (including temporary sections) hitherto unrepresented in the Museum collections.

Plastics Industry Education Fund

A further series of grants has recently been made to a number of technical colleges by the Plastics Industry Education Fund. A second scholarship—in addition to that founded last year—worth £300 per annum, tenable for three years for a full-time course leading to the associateship of the Plastics Institute, has been established at the National College of Rubber Technology, London. £1,000 has been allotted to the Borough Polytechnic, London, for the academic year 1957–58, to continue the payment of a number of existing bursaries to students entering the second year of the course for the diploma of the Plastics Institute; and a further £1,000 is provided to enable four scholarships to be awarded to students taking the four-year sandwich course in applied chemistry and chemical technology (group *A*, plastics), which is to start in September at the Borough Polytechnic, leading to the new diploma in technology. The Fund has agreed to set aside £650 per annum for five scholarships for students taking the four-year sandwich course, which will start next year at the Birmingham College of Technology, together with £1,000 for three scholarships for the one-year postgraduate diploma course in high polymer technology. Two awards, each of £100 annually, are to be made to Acton Technical College for four years for students taking the sandwich course in applied chemistry with plastics chemistry as their special subject.

National Museums, Ceylon

The Administration Report of the Director of the National Museums, Ceylon, for 1955 (pp. 32; Colombo: Government Publications Bureau, 1957) states that steps have been taken to initiate the building of the long-delayed northern extension. Judging by the large number of museums which have taken or are taking similar steps, it is certain that the 1950's will be remembered as a period of museum building on a wide scale. More than 180,000 visitors for the year are recorded, of which more than 25,000 were school children. Active archæological excavations were undertaken at Colombo, and a cave with a subterranean lake was investigated. Other departments undertook field expeditions, the results of which were examined by a scientific staff under the directorship of Mr. P. E. P. Deraniyagala. The report also includes a record of the work carried out at the Kandy, Ratapura and Jaffna National Museums.

Lunda and Zambezi Masks

We have become accustomed to a very high standard of scholarship and production in the publications of the Dundo Museum under its late curator, M. J. Janmart. It is delightful to find that both these standards are being maintained in a new volume by M. Redinha, who is now in charge of the Museum. The present excellent work (Companhia de Diamantes de Angola, Servicos Culturais. Publicacoes Culturais No. 31: Máscaras de Madeira da Lunda e Alto Zambeze. Por José Redinha. Pp. 70+28 plates. Lisboa: Companhia de Diamantes de Angola, 1956) consists largely of twenty-eight full-page illustrations in colour of various masks found in the Lunda and upper Zambezi areas, together with a brief description of each. These masks are mostly made of wood, and are at present exhibited in the Museum. In a short introduction—written in Portuguese, French and English—an account of these masks and their use is given. A favourite mask is the feminine Mwana-pwo, and when it is worn by a man while dancing he has to imitate female expres-

sions and poise. It is actually said that the women "learn graceful manners from the face and gestures of the mukishi Mwana-pwo [the dancer]". Of course, a mask of this sort has its origin in the social and political organization of a matriarchal type. The volume is a magnificent production and a lovely picture book full of interest for the anthropologist and indeed for the artist as well.

Early White Influence upon Plains Indian Painting

DURING the years 1832–34 the artists George Catlin and Carl Bodmer drew and painted the American Indians of the Upper Missouri, and before the days of photography it was their work which illustrated for the world the appearance and life of these aboriginal peoples. But they in their turn influenced the Indian artists, and it is this influence which forms the subject of a recent monograph by J. C. Ewers (Smithsonian Miscellaneous Collections. Vol. 134, No. 7: Early White Influence upon Plains Indian Painting. Pp. ii+11+12 plates. Washington, D.C.: Smithsonian Institution, 1957). The origin of the Mandan Indian painting is lost in antiquity, but early examples are known and can be studied. Data are now available to show the influence of the European artistic tradition of realism upon the painting style of the primitive American Indian artists of a century and more ago. It is not only in America that European art has influenced native traditional art. Angola is another case in point. There the natives every year decorate the outside of their houses, and more and more the influence of the white man's art can be observed. Again, though it has been stated that the painting tradition of the native boys at Cyrene in Southern Rhodesia is purely native, it would seem evident that, perhaps unconsciously, western European art traditions have also played their parts.

Nitrogen Metabolism in Tulips

OBSERVATIONS on the changes in the soluble nitrogen compounds of the tulip, especially in relation to flower formation, are reported by R. M. Zacharius, H. M. Cathey and F. C. Steward (*Annals of Botany*, N.S., 21, 193; 1957). They have found that the principal free amino-acid of the vegetative tulip bulb is arginine, the alcohol-insoluble nitrogen fraction containing combined arginine amounting to 47 per cent of the nitrogen. On the other hand, free arginine is virtually absent from the green leaf, but glutamine and asparagine, which occur there, are inconspicuous in the vegetative bulb. The changes in the soluble nitrogen compounds have also been ascertained during the inception and development of the flower to the stage when it emerges from the bulb. The latter process is attended by a notable change in the composition of the soluble nitrogen: the predominance of arginine declines and there is a relative increase in glutamine and asparagine. γ-Methyleneglutamine and γ-methyleneglutamic acid, which are prominent in the tuli[illegible] seem not to be greatly affected by the treatmen[illegible] that cause floral initiation and development. Their metabolism seems superimposed upon the nitrogen metabolism based on arginine in the bulb and amides in the leaf which is responsive to the treatments involved in flower formation.

Photoperiodic Responses in Tree Seedlings

IT is now known that the growth of many tree seedlings is promoted by exposure to long photoperiods, whereas very short photoperiods induce abnormally early dormancy. Information on this interesting phenomenon has been taken a stage further by O. Vaartaja (*Canad. J. Bot.*, 35, 133; 1957) in an investigation of the photoperiodic responses of the seedlings of a number of northern tree species. Seedlings of ten tree species were tested under two widely differing photoperiodic conditions in environment otherwise near optimum. The amount of light given to the plants was the same under both conditions. Under conditions simulating long photoperiods, the seedlings of all the species grew well and continued their growth during the eight-month experimental period. Under the short photoperiod, the following species remained nearly or fully dormant for several months beginning soon after germination: *Larix laricina*, *Ulmus americana*, and two provenances of *Picea glauca*. The following species either remained nearly dormant or grew significantly slower than under the long day conditions: *Betula lutea*, *B. verrucosa* and *Pinus banksiana*; *P. resinosa* was considered sensitive to photoperiods, but its responses in appearance and growth were small; *Caragana arborescens*, *Thuja plicata* and *Acer negundo* showed no significant response.

The Word 'Isotope'

ARRANGEMENTS are being made by the Glasgow and West of Scotland Section of the Royal Institute of Chemistry to affix a commemorative plaque to the house at 11 University Gardens, Glasgow, in which (probably in the winter of 1912–13) Dr. Margaret Todd (also known as the novelist 'Graham Travers') suggested the word 'isotope' to fit the concept developed by the late Prof. Frederick Soddy in the course of his radiochemical work as lecturer in the Chemistry Department of the University of Glasgow. The house (now University property) was then the home of Sir George Beilby, the metallurgist, who was Soddy's father-in-law. It was during a social evening at this house that Soddy expressed his need for a word to denote elements of different atomic weight occupying the same place in the Periodic Table; Dr. Todd immediately suggested 'isotope', and Soddy adopted the suggestion. The word had been used in a context of organic chemistry a few years earlier, but there is no reason to suppose that anyone then present was aware of the fact. The plaque will bear, in plain lettering, the names of Soddy and Margaret Todd, and a brief statement of the invention of the word in its radiochemical connexion. No public appeal for funds is being made.

Fading of Dyed Fabrics

AN interesting article by Mr. Garry Thomson, research chemist at the National Gallery, which appeared in the issue of the *Museums Journal* of May, contains some further studies on the effects of visible and ultra-violet radiation on museum objects, where the balance between the optimum conditions for display and conservation is always a problem. In the course of this work, four dyes on cotton substrates were examined after exposure to three chosen regions of substantially monochromatic radiation, namely, near-ultra-violet (3650 A. wave-length), blue-violet light (4047 and 4358 A.) and green-yellow light (5461 and 5780 A.). The distances of the samples from the light-source for each colour of radiation were carefully adjusted, so that all specimens received the same amount of light energy, and after fifteen

months exposure the amount and kind of colour-change in the sample were recorded by a Lovibond–Schofield tentometer. The results can be summarized by stating that for the dyes used, the ultra-violet component of sunlight through glass, or of fluorescent light, is of negligible importance in causing any kind of degradation. The author also states that in the matter of choice of illuminant the situation remains much as before except that intensity of illumination becomes even more important than type of illuminant (daylight, fluorescent or tungsten).

Radio Observations of a Lunar Occultation of the Crab Nebula

A paper by C. H. Costain, B. Elsmore and G. R. Whitfield (*Mon. Not. Roy. Astro. Soc.*, **116**, 4; 1956) describes the results of radio observations of a lunar occultation of the Crab Nebula on January 24, 1956. Observations of the previous occultation of the same nebula on November 30, 1955, which occurred low in the sky, were seriously affected by man-made interference and only the 1956 occultation is discussed. A short description is given of the aerial system, which was designed to discriminate between the radiation from the source and that from the general galactic structure, and also to allow continuous observation of the source for several minutes on either side of the calculated times of immersion and emersion. The record of the occultation at a wave-length of 3·7 m. and also a mean curve determined from records obtained on days before and after the occultation are given; in addition to the deflexion produced by the Crab Nebula, the records show minor contributions from other sources, especially from nebulosity *IC* 443 in Gemini. The radiation from the area occulted by the Moon at any time was easily determined from the differences of the curves, this difference being expressed as a fraction of the total intensity.

An important feature revealed by the study is the difference in apparent size of the radio-source as observed by radiation of two different wave-lengths. The radiation at 3·7 m. is confined to a region slightly larger than the visible nebula, but a considerable portion of the radiation at 7·9 m. comes from behind this region—a result which suggests that the object extends to a considerably greater radial distance than is revealed in photographs. An explanation of this in terms of the acceleration of fast electrons in weak magnetic fields is given at the end of the paper (cf. Oort, J. H., and Walraven, Th., *Bull. Astro. Ned.*, 12, 285; 1956). Among other matters discussed in the paper may be noted the deductions regarding the lunar atmosphere, based on the difference between the calculated and observed times of obscuration of the source. An electron density of 10^4 cm.$^{-3}$ was derived, a figure which corresponds to a surface density of the lunar atmosphere of about 10^{-13} of the density of the Earth's atmosphere.

Royal Commission for the Exhibition of 1851: Awards for 1957

The Royal Commission for the Exhibition of 1851 has awarded the following senior studentships for 1957 for research at the universities indicated: J. C. Coulson (Durham), for research in zoology; A. C. Das Chaklader (Leeds), for research in ceramics; G. J. C. Frohnsdorff (Imperial College of Science and Technology, London), for research in physical chemistry; J. A. Schofield (Cambridge), for research in organic chemistry. The Commission has also awarded the following overseas scholarships for 1957: Australia: L. M. Birt (Melbourne), for research in biochemistry at Oxford; Miss E. J. Pitman (Sydney), for research in mathematics at Cambridge; M. Moyle (Sydney), for research in organic chemistry at Oxford; E. A. Magnusson (New South Wales University of Technology), for research in theoretical chemistry at University College, London. New Zealand: J. E. Titheridge (University of New Zealand), for research in physics at Cambridge. South Africa: C. B. Cottrell (Rhodes), for research in entomology at Cambridge. Republic of Ireland: M. F. Lynch (National University of Ireland), for research in organic chemistry at the Technische Hochschule, Zurich. India: M. L. Dhar (Delhi), for research in organic chemistry at Oxford. Pakistan: S. N. Nabi (Dacca), for research in physical chemistry at Cambridge.

Perkin Centenary Awards

Mr. J. E. Bloor, of Manchester, has been awarded the Perkin Centenary Fellowship for study in the Department of Chemistry, Manchester College of Science and Technology, on the structure and properties of merocyanine dyes and related compounds. Perkin Centenary Scholarships have been awarded to Mr. James McCartney, of Newtownards, Northern Ireland, tenable at The Queen's University, Belfast; to Mr. Clive Milne, of East Ardsley, near Wakefield, Yorkshire, tenable at Bradford Technical College; and to Miss Gabrielle Griffin, of Withington, Manchester, tenable at the University of Manchester.

Lady Tata Memorial Trust Awards

The following awards for research on leukæmia and allied diseases during the academic year 1957–58 have been made by the Lady Tata Memorial Trust. *Grants for Research Expenses:* Dr. G. Klein (Karolinska Institute, Stockholm); Dr. M. Bessis (Centre National de Transfusion Sanguine, Paris). *Scholarship and Grant for Research Expenses:* Dr. G. V. Seaman (Department of Colloid Science, Cambridge). Various awards made to the following in previous years (see *Nature*, 177, 1208; 1956) have been renewed for a further year: Dr. J. Kieler (Fibiger Laboratory, Copenhagen); Dr. M. Seligmann (Institut Pasteur, Paris); Dr. M. Simonsen (Fibiger Laboratory, Copenhagen); Dr. B. Thorell (Karolinska Institute, Stockholm); Dr. G. Marinone (University of Pavia); Dr. A. J. Therkelsen (Institute of General Pathology, University of Aarhus).

Special Courses in Higher Techology

Part II of the Bulletin of Special Courses in Higher Technology, including management studies and commerce, issued by the London and Home Counties Regional Advisory Council for Higher Technological Education (pp. 61. 1*s.* 6*d.*), gives details of courses held in the spring and summer terms. The purpose of the Bulletin is to give publicity to special advanced courses held in the region which do not regularly appear in college calendars or prospectuses as part of a grouped course or as subjects offered for endorsement on Higher National Certificates. The courses are usually part-time evening courses, but the Bulletin also includes special full-time courses of not more than three months duration. Sessional evening postgraduate courses leading to higher degrees in science and engineering are not included, but colleges offering such courses and

having facilities for research are listed. There is an alphabetical index of courses as well as of colleges.

The Night Sky in July

FULL moon occurs on July 11d. 22h. 50m. U.T., and new moon on July 27d. 04h. 28m. The following conjunctions with the Moon take place: July 3d. 10h., Jupiter 6° N.; July 8d. 17h., Saturn 0·0° N.; July 29d. 08h., Venus 7° N.; July 31d. 00h., Jupiter 5° N. In addition to these conjunctions with the Moon, Venus is in conjunction with Mars on July 11d. 19h., Venus being 0·4° N., Saturn with Antares on July 18d. 03h., Saturn being 6·4° N., Mercury with Mars on July 23d. 22h., Mercury being 0·1° N., Venus with Regulus on July 25d. 04h., Venus being 1·2° N., and Mercury with Regulus on July 29d. 13h., Mercury being 0·2° N. Mercury is too close to the Sun for observation during the month. Venus sets about an hour after the Sun, and will be visible low in the west just after sunset. Mars is too close to the Sun for convenient observation. Jupiter sets at 23h. 20m. at the beginning of the month; it is near β Virginis. The stellar magnitude of Jupiter is −1·4 and its distance from the Earth in the middle of the month is 540 million miles. Later in the month observation will be difficult. Saturn sets at 2h. 05m., 1h. 00m. and 0h. 00m. on July 1, 15 and 31, respectively; it is in Ophiuchus, north of Antares. It has a stellar magnitude +0·5, and it is at a distance of 860 million miles from the Earth on July 15. There is one occultation of a star brighter than magnitude 6, observation being made at Greenwich: July 16d. 2h. 01·4m., × Aqr. (*R*); *R* refers to reappearance. The Earth is in aphelion on July 3, its distance from the Sun being 94·5 million miles.

Announcements

SIR CHRISTOPHER HINTON, managing director of the Industrial Group of the Atomic Energy Authority, has been awarded the Albert Medal for 1957 of the Royal Society of Arts "for outstanding leadership in nuclear power development". The Albert Medal is awarded annually for distinguished merit in promoting arts, manufactures or commerce.

MR. W. E. DICK, formerly editor of *Discovery*, has been appointed editor of *Chemistry and Industry*, the weekly journal of the Society of Chemical Industry, in succession to Mrs. Bush, who retires at the end of June.

MR. H. CAMPION, director of the Central Statistical Office, has recently been elected president of the Royal Statistical Society, in succession to Prof. Egon Pearson, who has retired after two years of office.

SIR EDWARD APPLETON will open the Mullard Radio Astronomy Laboratory of the University of Cambridge on July 25.

DR. GEORGE W. CORNER, of the Rockefeller Institute for Medical Research, New York, will deliver a lecture on "The Rockefeller Institute for Medical Research: its Founders and its Achievements", under the auspices of the Medical Research Council, at the National Institute for Medical Research, Mill Hill, London, N.W.7, on July 5, at 5 p.m.

THE National Vegetable Research Station at Wellesbourne, Warwick, is holding an open day this year on September 17, so that visitors will be able to see vegetables which were not ready at the time of last year's open day held in June.

THE National College for Heating, Ventilating, Refrigeration and Fan Engineering, at the Borough Polytechnic, London, is holding an open day on July 1, to demonstrate the teaching and research work of the Refrigeration Department; the Department will be open during 10 a.m.–5 p.m.

THE following have been elected to office in the Geological Society of London: *President*, Prof. L. Hawkes; *Vice-Presidents*, Prof. S. E. Hollingworth, Dr. F. Coles Phillips, Dr. W. Campbell Smith, Dr. E. I. White; *Secretaries*, Mr. A. J. Butler and Mr. J. M. Edmonds; *Foreign Secretary*, Prof. O. T. Jones; *Treasurer*, Mr. P. Evans.

THE 364th meeting of the Biochemical Society will be held in the Washington Singer Laboratories of the University of Exeter on July 19, starting at 11.15 a.m.

THE second World Metallurgical Congress, sponsored by the American Society for Metals, is to be held in Chicago, Illinois, during November 2–8, in conjunction with the annual U.S. National Metal Exposition and Congress. Some 650 scientists interested in metallurgy, representing thirty-six countries, including Australia, Belgium, Ceylon, Egypt, France, Germany, Great Britain, India, Indonesia, Israel, Italy, Japan, Liechtenstein, Sweden, Switzerland, Turkey and Yugoslavia, have accepted invitations to attend. Further information can be obtained from the Secretary-General of the Congress, W. H. Eisenman, 7301 Euclid Avenue, Cleveland 3, Ohio.

THE ninth British Mathematical Colloquium is to be held at the University of Nottingham during September 11–13. The Colloquium, which will be divided into four sessions on analysis and theory of numbers; algebra; geometry and topology; and analysis, is open to members of the academic staffs of universities, to Civil servants in scientific departments and, subject to limitations of accommodation, to research students. Accommodation will be available in the University halls of residence at a charge, including meals, of £4 15*s*. There is an additional Colloquium membership fee of 10*s*. Inquiries should be addressed to Dr. M. E. Noble, Department of Mathematics, University of Nottingham.

A SYMPOSIUM on "Microchemistry", under the auspices of the Society for Analytical Chemistry and organized by the Midlands Section and Microchemistry Group, will be held in the University of Birmingham during August 20–27. It will consist of original papers and recent advances in microchemical techniques, presented by a number of chemists of international repute under the presidency of Prof. M. Stacey. The subjects will include: inorganic and organic qualitative and quantitative analysis; absorptiometry; chromatography; polarography; emission spectrography; radio chemistry; chemical microscopy; thermogravimetric analysis; biochemical methods; industrial applications; and teaching. Registration forms and further information may be obtained from the Symposium Secretary: Mr. W. T. Elwell, Imperial Chemical Industries (Metals Division), Ltd., P.O. Box No. 216, Research Department, Kynock Works, Witton, Birmingham 6; envelopes should be marked "Symposium".

ERRATUM. In the communication entitled "Phosphatases in the Central Nervous System" in *Nature* of June 15, p. 1247, col. 2, line 12 of text and in the legend of Fig. 1, for "axon" read "dendrite".

CHALK LIME AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

OPENING OF NEW LABORATORIES

THE Chalk Lime and Allied Industries Research Association was formed in February 1955 following discussions between a number of lime manufacturers, sandlime brick manufacturers, and the Department of Scientific and Industrial Research. Its constitution follows the general pattern for Government-aided research associations, and the scope of its membership extends to British firms producing or marketing lime or chalk, or products made wholly or partly from these materials. There is also an associate grade of membership for firms having an indirect interest in the industries principally concerned, for example, machinery manufacturers, and for individuals interested in the work of the Association.

The membership is now more than thirty, about equally divided between the lime and sandlime brick industries. The affairs of the Association are governed by a Council, consisting of elected ordinary members together with representatives of the Department of Scientific and Industrial Research. Mr. W. L. Clarke is chairman of the Council, and Mr. G. E. Bessey is director of research. Mr. Bessey had previously held a similar appointment in the Research Council of the British Whiting Federation, and was earlier for many years on the staff of the Building Research Station.

The Association moved into its new laboratories at Welwyn, Hertfordshire, in September 1956, and the building was officially opened on May 16 by Sir Albert E. Richardson. While the Association is potentially concerned with all aspects of chalk and lime, research is at present concentrated largely on the use of lime in building and road construction, and on sandlime (calcium silicate) bricks. Though lime has been burned since the time of Plutarch, there is much scope for fundamental research into the nature of this reaction and of the reactions in the subsequent hydration of quicklime. Several research projects of more immediate practical application are at present in progress, and a number of reports have already been issued to members. Present activities are principally in the fields of the analytical and physical chemistry of lime and materials produced from it, the rheology of mortars, and the structural and chemical features of soil in relation to its stabilization with lime for road and foundation construction.

Sandlime bricks have been known for less than a hundred years. The process of hardening a mixture of silica sand and lime by treatment with steam under pressure has been developed in a more scientific age than the evolution by tradition of the lime industry, but until the formation of the Association, research in this field has been sporadic and now the industry will have its own co-operative research organization. Research is in progress on the nature and properties of the calcium silicate hydrates which are the basis of sandlime bricks, and on a number of topics of immediate importance.

The Association maintains close contact with the Building Research Station and with the Road Research Laboratory. Some of the Association's staff have been working at the Building Research Station as a temporary measure, and others are stationed at the Road Research Laboratory as part of a team engaged on joint research on soil stabilization using lime.

The new laboratory accommodation at Welwyn allows facilities for analytical and physical chemistry, physics, heavy mechanical testing, photography and other ancillary services, and for experimental building work for observation of the behaviour of materials in practical use. The pleasant three-acre site allows room for future expansion. An information, library, and liaison service is provided for members and staff, the library itself being run in co-operation with the Research Council of the British Whiting Federation in neighbouring premises. Although the Association has been functioning for two years, the recent opening ceremony has provided an opportunity for the members and a large number of visitors to become more closely acquainted with the Association's work and to see something of the research in progress and the apparatus and techniques which are in use.

THE KARL PEARSON CENTENARY LECTURE

ON May 13, Prof. J. B. S. Haldane delivered at University College, London, a lecture in celebration of the centenary of Karl Pearson's birth. The theatre was packed and a substantial overflow meeting had to be organized. Not the least tribute to Pearson's gifts as a teacher was the large number of his former students, many of them distinguished in their own right in a great variety of fields, among the audience.

Haldane began by examining some criticisms, fair and unfair, of Pearson's work. All power corrupts, and Pearson's power as a head of an important department and the editor of an important journal led him to make mistakes. But it is easier to see this now than fifty years ago when the mistakes were made. It has even been claimed that by espousing a false theory of heredity he was a hindrance to progress. Haldane believes, in fact, that Pearson's theory of heredity was incorrect. But so, he remarked, was Columbus's theory of geography. In his search for a self-consistent theory of evolution, Pearson devised methods which are not only indispensable in any discussion of evolution; they are essential in every serious application of statistics.

Pearson was a forceful personality with a bewildering range of interests and knowledge. At Cam-

bridge he was Third Wrangler in 1879; he spent a year in Germany attending lectures on philosophy, Roman law, physics and biology, was called to the Bar in 1881, took part in sundry radical activities in London, and in 1884, at the age of twenty-seven, was appointed to the chair of applied mathematics and mechanics at University College, London. His first original publication after appointment was a study in German of the Veronica portraits of Christ in the Middle Ages. His search for a religious system which his intellect would allow him to accept resulted in his "Ethic of Freethought" in 1888.

But if, says Haldane, one had to pass judgment on Pearson in 1890, it might have run as follows: "He is a first-rate teacher of applied mathematics and a scholarly compiler of the work of more original men. He has a knowledge of literature and art most unusual in a professor of mathematics. He is something of a radical, but he is only thirty-three years old. . . . He will never produce work of great originality, but the College need not be sorry to have appointed him". In point of fact, Pearson was at the threshold of his life's work.

In 1890 there occurred two events which shaped his future life. He was appointed to the lectureship in geometry at Gresham College; and Weldon succeeded Lankester in the chair of zoology at University College. The lectures Pearson gave at Gresham College developed into the "Grammar of Science". His association with Weldon stimulated him to apply probability and statistical method in a host of new fields.

The "Grammar of Science" may not rank with the greatest works of philosophy, but in Haldane's opinion it was freer from contradiction than other contemporary works such as Mach's, and Pearson is to be regarded as one of the founders of logical positivism. Its effect on generations of young readers has been profound. Not the least tribute to its influence is the respect which it exacted from one of its strongest critics, Lenin.

The year 1890 saw the first of a long series of memoirs on mathematical contributions to the theory of evolution, and for another forty years paper after paper appeared with impressive regularity and an astonishing coverage. Some of Pearson's theoretical work has become standard practice, notably his derivation of the so-called chi-squared test in 1900. Through Weldon he met Galton, and the three founded *Biometrika* in 1901, Pearson becoming editor and one of the principal contributors. He was now in the full pride of his scientific strength, but apart from his own original contributions, found time to obtain outside financial help for his research (quite a feat in those days), to begin the systematic collection of data—the "Treasury of Human Inheritance" is still indispensable—to lecture on theoretical statistics and the history of scientific method, to produce some standard sets of statistical tables, and to take part in numerous ephemeral controversies.

Not until 1920 was the Department of Applied Statistics founded at University College, and by then Pearson was sixty-three. But with unabated vigour he set about organizing the Department and laid foundations which are still firm. He relinquished his chair in 1933 and died three years later. At University College his work is now being carried on by three professors.

Haldane concluded with some references to the science of biometry and his own feeling that the Pearsonian impulse in this direction is now more profitably at work overseas, especially in India. He may be right; but the momentum of Pearson's prodigious energy and courage is still felt in Britain. He was a man who must be looked at in the round and, for all his faults, possessed the supreme gift of inspiring affection and scientific enthusiasm among a wide following of students. To him more than to any one man is due the fact that the United Kingdom took and has held the lead in the development of statistical methods.

CROP PROTECTION

SINCE its inauguration in 1949, the International Symposium on Crop Protection has catered for, and continues to satisfy, the regional needs of Belgium and Holland and the interests of a few specialized institutes, societies and commercial groups in France, Western Germany and Great Britain. Throughout, the arrangement of the Symposium has been in the able hands of Prof. J. van den Brande, rector of the College of Agriculture at Ghent, and the general organization has benefited from this continuity.

The ninth Symposium, held at Ghent on May 7, had the great merit of being a small conference, lasting officially for only one day. The Symposium has shown a tendency to expand and now, instead of the single day devoted to two plenary sessions formerly enjoyed by all members, according to the subjects concerned, the ninth Symposium had five sections meeting simultaneously in the morning and only the afternoon was devoted to a plenary session.

Since pests, diseases and weeds are now included in the term crop protection, the opportunity is taken to keep under review the advances in methods and techniques, whether these apply to the laboratory or the field, to present new knowledge and suggest its application, to describe and discuss new uses of established plant protectants, and to recognize limitations in plant chemotherapy, disappointing though this may be in particular cases.

On this occasion these several aspects were dealt with in the sectional meetings, while at the plenary session two papers only were presented: a brilliant review of the possibilities for new approaches to insect control, by Dr. J. de Wilde (Netherlands), and a comprehensive description by P. C. LeFevre (Belgium) of the organization of the plant protection service in the Belgian Congo.

There is necessarily a slight difference in emphasis from year to year, and on this occasion two trends were noticeable—a more critical interest in plant parasitic eelworms and their control, and a readiness to recognize that biological details, whether in the zoological or botanical fields, are pertinent to any discussion on crop protection.

Progress in the investigations on the control of potato root eelworm (*Heterodera rostochiensis*) was reported by Prof. van den Brande and his collaborators at the Ghent School of Agriculture. They showed that even an efficient nematicide like DD may give results that vary from place to place, depending upon the nature of the soil. Studies on different types of soil, both in the laboratory and the field, showed that the main factor was the water content, for upon this depended the rate of diffusion and the concentration of the nematicide. Messrs. Besemer and Oostenbrink reported from Wageningen that DD applied at the rate of 50–60 cm.^{3}/m.^{2} was still the most reliable nematicide for use against anguilluline

eelworms in nursery stock, in flower crops and in carrots. Against root knot eelworm under glass, ethylene dibromide at twice the usual dosage of 45–60 cm.³/m.² gave good results. Some of the newer products, while showing approximate killing efficiency, had the disadvantage of remaining phytotoxic for six weeks or more after application—a serious handicap in horticultural soils where a quick succession of cropping is essential. The use of sodium methyl dithiocarbamate, a good general soil sterilizer against eelworms and fungi, was described by Messrs. Linden and Schicke (Ingelheim), who showed that mixing-in or injection at the rate of 100 cm.³/m.² are both preferable to watering-in. They recognize the phytotoxicity risk, and recommend that soil heaps in the open air should be treated in summer as early as possible before use; if left until November it is not safe to use the soil until March. Lettuce is very susceptible to injury by this sterilizer and is therefore a good indicator of the time for safe planting. Eelworm attack on carrots has been recognized as a puzzling problem; the species of eelworm concerned was described only as recently as 1949 by Thorne as *Hoplolaimus uniformis*. Soil treatment with DD and with formalin gave a high kill of this eelworm, and was followed by markedly improved growth. Other studies by Kuiper and Drijfhout (Netherlands) showed that, in infested soil, crop rotation influenced yield; the yield of carrots following potatoes proved to be better than that following either sugar-beet or carrots.

The beet eelworm survey in northern France was described by Dr. M. Christmann, of the Institut Technique de la Betterave, Paris. He showed that the Institute can handle up to two thousand soil samples per year and use its accumulating knowledge of the rate of decrease in viable cysts, in particular regions and localities, as the basis for its advisory work. Another contribution from France was an interesting paper by Dr. F. Chaboussou, director of the Institute of Agricultural Zoology of the Gironde. He described investigations on the plum codlin moth, *Laspeyresia funebrana*—a most troublesome pest throughout western Europe, and one that is outstandingly difficult to control. Spraying of plums with oleoparathion in early July when 75–80 per cent of the caterpillars were hatched, but before the fourth instar was reached, gave a total kill of more than 90 per cent with a single treatment. It was noted that the fourth and fifth instars are not easily reached as they are deep in the fruits. There is, in practice, a period of about eight days during which spraying can be very effective.

Three speakers presented papers on the subject of spider mites. J. Meltzer showed that ovicides, such as CPBS and CPCBS, applied to the upper surface of bean leaves, are capable of killing red spider eggs laid afterwards on the lower surfaces, and eggs already laid there may also be killed as well as a high proportion of the immature stages. With tedion, which penetrates the leaf more slowly, the toxic action lasts for as long as three weeks. R. Delhaye has been investigating the use of emulsions containing phosphoric ester, white oil and ammonium thioricinate and claimed good results against red spider on vines and peaches under glass. M. van de Vrie's observation on the strawberry tarsonemid mite greatly interested his audience. He emphasized the difficulty of controlling, in the field, mites the development of which takes place largely in the very young unfolded leaves in the crown. The esters of phosphoric acid are not really satisfactory in this case, and endrin and kelthane, though active for a long period through their toxic residues, are not desirable on fruiting beds because of their high mammalian toxicity. Mr. J. Bernard, of Gembloux, on the other hand, was concerned with trying to secure mammalian toxicity—in control of the field vole, *Microtus arvalis*. He found that while red squill is not satisfactory, coumaphene in baits with crushed oats or flour is more effective, but this species of vole is more resistant to this poison than the laboratory white rat.

Other subjects that occupied the conference were soil disinfection, antibiotics for use on horticultural crops, fungus control in pine nurseries, seed disinfection of flax, the aerial fungus flora, exobasidium of the azalea, a crop of great importance in Belgium particularly, and the bacterial canker of poplar, a crop tree of great economic value from the Netherlands right down to Italy. Herbicides, too, received attention, and particularly those for use in strawberry beds, in nurseries, and in flax crops.

In the tropical section of the symposium, P. L. G. Benoit dealt with the distribution and behaviour of flies the larvæ of which cause myiasis in man and animals in the Belgian Congo. A. Gillard and Prof. J. van den Brande described the recent collection of new species of *Heterodera*-type eelworms in the Congo and directed attention to their economic importance, and Prof. P. A. van der Laan discussed the use of the insecticide toxaphene and emphasized its advantages under tropical conditions. The control of rice pests, and notably of the injurious molluscs *Pomacea lineata* and *P. glauca*, was described by J. van Dinther, who obtained good results against these molluscs with applications of either copper sulphate or BHC.

The organizers of the symposium can be congratulated on its success, and the participants—and indeed the much wider public vitally concerned with the subjects covered—will look forward to the early publication of the papers in full. H. W. Miles

SOME RECENT ADVANCES IN SPECTROSCOPY

A CONFERENCE on spectroscopy, held in the Department of Chemistry in the University of Western Australia during February 20–21, was attended by about forty persons, including a number of visitors from the eastern States. The meeting was opened by Dr. A. L. G. Rees (Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization), who surveyed recent developments in the field of spectroscopy. The major theoretical advance in recent years has undoubtedly been the introduction by Bayliss of the free electron approximation in quantum mechanics and its subsequent development, mainly by American workers. New techniques of special importance are the magnetic methods based on nuclear and electron spin resonance which can provide useful chemical information. Other notable advances in technique are echelle spectroscopy, due to Harrison, the high-intensity Raman source developed by Welsh at Toronto, and the development of multiple-pass spectroscopy and a method of analysis based on atomic absorption spectra, both due to Walsh and his colleagues. Also of importance are the developments by Watanabe

and Williams of direct-reading vacuum ultra-violet spectroscopy and of electron-impact spectroscopy by Morrison. Important new observations include the measurement of rotational Raman spectra, the discovery of intermolecular combination bands, and the discovery by Bayliss and Brackenridge of spurious bands in solution spectra near the edge of intense solvent absorption bands. Outstanding problems are associated with the general unsatisfactory state of quantum-mechanical calculations; new and improved methods are badly needed even for simple molecules. Moreover, the problems of the computing of intensities of infra-red and Raman spectra and the determination of the causes of solvent shifts of absorption spectra are as yet unsolved. Many other important problems are associated with the Raman excitation, absorption and emission of solids and the investigation of unexplored regions in the very far infra-red.

The remainder of the first session was devoted to research contributions. Dr. A. R. H. Cole (Department of Chemistry, University of Western Australia) discussed the infra-red spectra and stereochemistry of *cyclo*hexane derivatives. No simple method is available for determining the preferred conformations of di- and tri-substituted *cyclo*hexanes in which there may be competition between substituents as to which will occupy the more stable equatorial position. Dr. Cole described the infra-red absorption due to free and hydrogen-bonded (intramolecular) hydroxyl groups in a series of *cyclo*hexane-1,2-diols, each of which carries one or two other substituents of different sizes in the axial (*a*) and/or equatorial (*e*) position. A large group such as *iso*propyl can act as an anchor holding a *cyclo*hexane ring in one conformation ((*e*)-*iso*propyl) and can prevent hydrogen-bonding between a *trans*-1,2-diol system by keeping the hydroxyl groups in the diaxial form. 1-Ethyl-*cyclo*hexane-*trans*-1,2-diol exists as an equilibrium mixture of (*e*)-ethyl-(*a*)-diol and (*a*)-ethyl-(*e*)-diol, and intensity measurements of free and bonded hydroxyl absorption carried out by Miss G. T. A. Muller show the mixture to contain 35 per cent of the former. 1-Methyl*cyclo*hexane-*trans*-1,2-diol, on the other hand, exists completely in the (*a*)-methyl-(*e*)-diol conformation which allows relatively strong hydrogen-bonding. The measurements were extended to a series of *p*-menthane diols, and it was shown that at room temperature *trans*-2-hydroxy*neoiso*menthol exists as an equilibrium mixture containing 68·5 per cent of the (*a*)-methyl-(*a*)-diol-(*e*)-*iso*propyl conformation. From this it can be readily deduced that the conformation of *neoiso*menthol is (*a*)-methyl-(*a*)-hydroxyl-(*e*)-*iso*propyl. Lowering of the hydroxyl stretching frequency due to hydrogen-bond formation can be related to the conformation and in suitable cases can be used to determine configurations of *cyclo*hexane-1,2-diols.

Mr. A. Walsh (Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization) described the development with Dr. N. S. Ham of a new Raman source. Methods for obtaining the necessary intensity for Raman spectra studies invariably make use of the mercury arc. The equipment is often very bulky, requiring the use of either several mercury lamps—the light being concentrated by multiple reflexion—or of water-cooled arcs drawing as much as 50 amp. (Toronto source). The design of the Melbourne source was also stimulated by the need for a source of longer wave-length for the study of the vibration frequencies of the iodine molecule in solution. The new source, which was demonstrated, is electrodeless and consists essentially of an annular jacket containing a rare gas and an alkali metal or mercury. For excitation a high-frequency diathermy source (2,450 Mc./s.) provides extremely intense illumination. By using cæsium as the alkali metal it is hoped to obtain a Raman source of wave-length 8521 A. Very few molecules absorb appreciably in this region.

Prof. N. S. Bayliss (Department of Chemistry, University of Western Australia) followed with an account of studies on the effects of solvents on infra-red intensities carried out in collaboration with Dr. A. R. H. Cole and Mr. L. H. Little. In this work the intensities of the C=O stretching frequency in acetone and other ketones, of the C≡N stretching frequency in a series of aliphatic and aromatic nitriles, and of the S—H stretching frequency in several mercaptans were all measured in a series of solvents with a wide range of dielectric constants. All the spectra show changes of intensity with change of solvent, the change being particularly large for the C≡N and the S—H bands. The nitrile intensities, for example, are more than twice as large in chloroform as in *iso*octane, while the mercaptan intensities are eight times as large in pyridine as in *iso*octane. The general trend observed was that intensities increase with the dielectric constant of the solvent, but there are marked individual exceptions to this rule. The C≡N intensity for benzonitrile is in all cases about four times as large as for acetonitrile in the same solvent. A puzzling feature is that the C≡N intensity for phthalonitrile, with two nitrile groups, is only about one-half the intensity for benzonitrile with one nitrile group. No current theory is capable of explaining the experimental results. The classical theories of Chako and of Schuyer are far from reproducing the intensity changes, and while the quantum theory of Hirota is rather closer, it still does not account for the large intensity variations observed. There is also no adequate theoretical explanation of the fact that the half-width of the bands observed in solution is in all cases considerably less than the half-width of the same bands observed in the gas. Current quantum theory of infra-red intensities relates the intensity to the change of bond moment with inter-nuclear distance. The problem is to determine how this quantity is affected by the solvent environment.

The second session commenced with a paper by Dr. A. L. G. Rees on the theory of solvent effects. To account for solvent effects on spectra it is formally necessary to set up the wave equation of the whole assembly of particles, both solute and solvent, in the liquid. In view of the impossibility of solving such an equation, it is convenient to approximate by considering a single solute molecule surrounded by a nearest-neighbour shell of z solvent molecules. There are experimental grounds for believing that the influence of more remote solvent molecules can be neglected to this degree of approximation. In terms of the Franck–Condon principle, the molecular environment is static during an optical transition. In general, the nearest-neighbour environment of a particular solute molecule is unsymmetrical. The perturbation due to the environment can be expressed in terms of three components, which are respectively independent, and even and odd functions, of the co-ordinates. The application of first-order perturbation theory then makes it possible to set up a formal expression for the transition moment in solution. A significant result is that not only

transitions which are allowed in the free molecule will be altered in intensity, but also that transitions which are totally forbidden in the free molecule will acquire a first-order transition moment in solution owing to the operation of the unsymmetrical part of the perturbation. This general theory can be applied to the intense ultra-violet band shown by halogens in aromatic hydrocarbon solutions. Although this band has been attributed by Mulliken to complexes, the present theory suggests that it is more likely to be associated with a known totally forbidden transition in the free molecule.

Mr. C. J. Brackenridge (Department of Chemistry, University of Western Australia) then described changes in the ultra-violet spectrum of *s*-trinitrobenzene with the composition of seven binary solvent mixtures all containing aniline and covering the complete composition range. Aniline was chosen because of its notable effect in enhancing the absorption in the 4000 A. region. When the results were plotted in accordance with Scott's rearrangement of the Ketelaar equation, which predicts a straight line for 1 : 1 solute–solvent complex formation, and from which the equilibrium constant can be determined, an interesting effect was observed. Points of discontinuity appeared in the vicinity of 0·5 aniline mole fraction in all seven systems showing that, although linear plots could be drawn in several cases on both sides of the point, they are incompatible with the postulate of complex formation. In the two systems hexanol–aniline and ethylene glycol–aniline, the effect of temperature on the *s*-trinitrobenzene spectrum was studied. The heat of formation was calculated on the highly improbable assumption that one of the plots on either side of the point represented solvation. In both systems the H values were low and their sign changed on either side of the point of discontinuity. It is suggested that the point of discontinuity indicates a molecular rearrangement arising in the course of a physical perturbation.

The session concluded with a description by Mr. J. V. Sullivan (Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization) of his investigation of the causes of certain anomalies in the spectrum of iodine. These anomalies are lack of reproducibility of the molar extinction coefficients, ε, high values of the coefficients in the region from 4000 to 2200 A., and a sharp rise in the spectral curve from approximately $\varepsilon = 100$ to $\varepsilon = 600$ in the region 2100–2000 A. Furthermore, a shift of the order of 500 kaysers, generally towards longer wave-lengths, has been observed in the peak of the curve in the visible region. Extensive investigation now shows that the anomalies are very probably due to the formation of an adsorbed iodine layer on the end-windows of the cell. Experiments on cells made up with internal windows, which allow greater concentrations of the adsorbed layer, have shown the expected increase in the molar extinction coefficients.

The final session of the Conference commenced with a paper by Mr. A. Walsh describing the analytical advantages of absorption spectroscopy and the technique of measuring atomic absorption spectra. Analyses by emission spectra lack sensitivity since even at very high temperatures only a small proportion of atoms are excited to emission, while almost all of the atoms are potential absorbers. Measurements of absorption spectra, which are free from complications such as inter-element effects, self-absorption and self-reversal, therefore have many advantages. Rather than use a continuous source, it is more feasible to measure the absorption coefficient at the centre of the line using a sharp-line source such as a hollow-cathode discharge tube. Modulation of the incident radiation is necessary to avoid recording radiation emitted by the vaporized sample. By using copper as standard, it has been possible to determine approximately the oscillator strengths of a number of elements. While the method has proved successful for the analysis of many elements, some, such as aluminium, are not atomized in a flame. Samples have been vaporized both from solutions sprayed into a flame, and from alloys by a sputtering discharge through a rare gas. In the latter case inter-element effects are present, but the method is likely to prove useful both for analysis and for the study of sputtering behaviour. Several optical variants of the apparatus used were described.

The Conference concluded with the presentation of two papers from the Department of Physics of the University of Western Australia. Mr. R. S. Crisp described a grazing-incidence high-vacuum spectrometer which had been constructed specifically for the study of the soft X-ray band emission spectra of metals in the range 50–1000 A. The spectrometer utilizes two interchangeable ruled aluminium gratings with 570 and 1,150 grooves/mm. The diffracted, focused radiation is detected by an Allen-type, open, beryllium–copper photo-multiplier and attached analyser slit, which are mechanically driven around the Rowland circle. The output pulses from the multiplier are amplified and counted on a counting rate meter ; a continuous record of detected intensity is given by a recording potentiometer as the analyser slit traverses the spectrum. In such an instrument the resolution achieved depends not only on the optical resolution of the combination of grating and slits, but also on the statistical deviation and response-time of the counting rate meter and the speed of traverse of the spectrum. A certain minimum speed is fixed by considerations involving long- and short-term contamination of the specimen surface and consequent modification of the observed band shape. A study has been made of the variation of contamination of specimens with time by observing the fall in intensity at a particular wave-length as the contamination proceeds. Spectra were shown which had been obtained for the metals, magnesium, aluminium, lithium, sodium, potassium, beryllium and copper. The 'roll-over' on the high-energy side of the peak of the lithium–potassium spectrum, which was observed by Skinner and queried by Schiff, and Jones and Schiff, has been indisputably observed. The 'emission edges' observed by Gyorgy and Harvey for the M-spectrum of copper, which were not observed by Skinner, Bullen and Johnson, also were not observed with the present instrument. Further investigations will be directed towards the determination of the changes in band shapes and band widths and of edge widths and edge shifts in the spectra of the components of solid solutions.

Mr. M. R. Meharry described work on the luminescence of the alkali halides irradiated in the vacuum ultra-violet. The variation in fluorescence efficiency *versus* exciting wave-lengths for some KCl : Tl and KI : Tl phosphors was studied in the wave-length region 900–2300 A. At long wave-lengths, this was found to be correlated closely with the transmission spectrum of the pure crystal. This was considered evidence that only direct excitation of the Tl^+ centres occurred and that no exciton-induced fluorescence

took place. A fluorescence growth under steady excitation and a phosphorescence decay in the dark were observed at wave-lengths less than those corresponding to the series limit for the respective crystals. This was interpreted in terms of a series of trapping and excited energy-levels in Tl^{2+} as proposed by Johnson and Williams. A series of experiments on photoconductivity gave negative, though not necessarily conclusive, results at wave-lengths less than that generally accepted for the series limit. Also, an observed sharp rise in fluorescence of KI : Tl at 1000 A. remained unexplained. It was proposed that, in order to explain the latter results, the ionization limits for KCl : Tl and KI : Tl must be situated at much shorter wave-lengths than the accepted wave-lengths of 1300 A. and 1750 A., respectively.

G. A. ELLIOTT

COLLOQUE A.M.P.E.R.E., 1957

THE 1957 meeting of the Colloque A.M.P.E.R.E. (Atomes et Molécules par Etudes Radio-Electriques) was held at St. Malo during April 24–26. The conference, which is held annually, is primarily concerned with the study of the properties of materials with the use of radio-frequency electromagnetic waves. The subjects discussed were dielectrics, electron paramagnetic resonance, ferromagnetic resonance, microwave spectroscopy of gases, nuclear magnetic resonance, and quadrupole magnetic resonance. The meeting was attended by some two hundred scientists, the majority being from French laboratories, but with visitors from most European countries, including East Germany and Poland and some from as far as Venezuela and Australia. The organizers of the Conference take pride in the fact that the proceedings are conducted almost entirely in French without apparent effort on the part of the foreigners present.

Some seventy papers were presented mainly in the form of ten-minute summaries, preprints being available beforehand. This rather heavy programme, combined with splendid weather and French hospitality, made it rather difficult to follow the programme as closely as one might have wished. Prof. R. Freymann, who is the leading spirit of the Colloque A.M.P.E.R.E., was probably the only person both to attend every session and be at a banquet every evening. Such energy bodes well for French science.

It is evidently impracticable to report each paper and I shall pick out those which I hope will be representative of the Conference. The papers are published in book-form by the Archives des Sciences, and are available from the Institut de Physique, Université de Genève, price 25 Swiss francs. The discussion at the Conference is not recorded or published, as it is feared that this would tend to suppress a free and frank exchange of views.

The session on dielectrics was opened by Prof. H. Fröhlich (Liverpool), who discussed under what conditions trapped electrons at vacancies in ionic crystals would result in dielectric loss of the Debye type. He showed that this may occur, even for single stationary vacancies, when electron lattice interactions are included, whereas previously it has usually been supposed that moving vacancies which simulate a rotating dipole are necessary. S. Dryden (Sydney) reported recent work on Debye-type dielectric absorption in ionic crystals, which they have now found in eleven simple ionic crystals and tentatively associate with diffusion of lattice vacancies. M. J. Meinnel and R. Clinet (Rennes) discussed the dielectric effects of the transitions in the ammonium halides, and demonstrated the absolute necessity of removing all traces of water. F. Lasbleis *et al.* (Rennes) presented results on dielectric absorption and phase changes in a series of titanates. J. Meinnel and F. Trigolet (Rennes) reported dielectric measurements on hexagonal selenium; they find a Debye absorption which is displaced by suitable irradiation, the effect depending on its intensity and wave-length. Prof. R. Freymann (Rennes) reported on various projects, including dielectric measurements on thiourea and on semi-conductors containing various impurities.

Prof. R. H. Cole (Brown University) presented a survey of his dielectric measurements on liquid alkyl halides and mixtures of these with other organic liquids, in the supercooled state. For the mixtures one sometimes finds one dispersion region and sometimes the original two, for which no satisfactory explanation is at present available. J. Ph. Poley and A. J. van Eick (The Hague) presented further results on the two dispersion regions in liquid chloro- and bromo-benzenes. L. de Broukère and M. Mandel (Brussels) suggested a method of explaining the spectrum of dielectric relaxation times in high polymers which is based on a consideration of freedom of motion of chain segments. F. C. de Ronde (Eindhoven) proposed a new method of measuring electric and magnetic constants of solids in the microwave region. C. Brot and A. Soulard (Paris) described a special resonant cavity for the frequency range 100–1,000 Mc./s. which appears to facilitate measurements in this difficult region.

In the sessions on electron paramagnetic resonance there were several papers on free radicals. G. Berthet (Fontenay) has studied some stable free radicals, particularly with regard to the hyperfine structure. Some new radicals have been discovered by Y. Fellion and J. Uebersfeld (Paris). F. W. Heineken and F. M. Schimmel (Amsterdam) find that some stable free radicals may be sensitive to oxygen, just like induced ones. M. Bruma (Paris) described a ferrite circulator which seems to have advantages over the 'magic *T*' and similar devices used in paramagnetic resonance equipment. D. J. E. Ingram and J. F. Gibson (Southampton) gave results for radicals formed by ultra-violet irradiation of glass-forming substances at low temperatures. D. H. Whiffen *et al.* (Birmingham) have studied a number of polymers under gamma-irradiation and J. S. van Wieringen (Eindhoven) has investigated glasses subjected to several types of irradiation. At the moment the interpretation of these effects is rather uncertain. D. J. E. Ingram (Southampton) described how structural data on large molecules may be obtained from electron resonance in favourable cases, for example, with hæmoglobin. J. Uebersfeld and E. Erb (Paris) reported further work on paramagnetic centres in carbon. E. E. Schneider (Newcastle) reported further results on alkali halides doped with manganese and on X-irradiated lithium fluoride. A. Gozzini *et al.* (Pisa) have measured magnetic birefringence effects using DPPH.

The ferromagnetic resonance in a single crystal of iron has been studied by A. Strub (Grenoble). J. Munier and P. Sermet (Grenoble) have developed a ferrite microwave attenuator with 'electronic' control.

The session on nuclear magnetic resonance was introduced by Prof. C. J. Gorter (Leyden), who reported on current work in this field in his laboratory. N. J. Poulis and G. E. G. Hardemann (Leyden) reported further measurements on a single crystal of cupric chloride. A. Lösche (Leipzig) reported on the use of nuclear resonance in studying the rate of slow polymerization by comparing the signal from protons in the solid (polymer) and liquid (monomer) phases. R. Extermann (Geneva) gave a review of the work of the Geneva group which has been particularly concerned with magnetic resonance at low fields. A. Abragam and W. Proctor (Saclay) discussed their work on 'spin calorimetry', one result of which is a trick for polarizing nuclei which have an inconveniently long spin-lattice relaxation time (weeks, say) in a matter of seconds. A. Abragam and I. Solomon (Saclay) have studied the spin echoes obtained when a nuclear absorption line is subject to quadrupole splitting. The results differ considerably from the usual ones, in that 'echoes' may be observed at $\tau/2$ and $3\tau/2$ as well as τ after the stimulation. Abragam's group have also observed the Overhauser effect in liquids containing paramagnetic impurities which has the peculiar property that there is at first a diminution in the nuclear signal (Underhauser effect). The increase in intensity obtainable could be invaluable in the study of weakly magnetic nuclei. J. G. Powles (London) discussed measurements on poly*iso*butylene solutions in organic liquids over a wide range of concentration which give information on chain motion in this polymer. J. Hue and J. Seiden (Paris) have produced a simplified theory of double resonance.

A study of hyperconjugation in molecules by means of microwave spectroscopy was reported by J. Sheridan *et al.* (Birmingham). Results by the same method on formic acid were given by R. Wertheimer (Paris). J. Bonanomi *et al.* (Neuchâtel) have constructed an ammonia 'maser' and have studied particularly the reproducibility of such equipment. This communication provoked the usual argument about the meaning of time. Prof. A. Kastler (Paris) gave a review of his work on magnetic resonance in optically excited systems of various types.

The last session was concerned with nuclear quadrupole resonance. Prof. Kastler pointed out that Maupertuis, a native of St. Malo, was the first to measure the departure of the earth from sphericity and hence was one of the first to measure a quadrupole moment. F. Lurçat (Paris) showed how one can obtain macroscopic equations of motion for quadrupole resonance absorption corresponding to the Bloch equations for nuclear resonance. M. Buyle-Bodin (Grenoble) has studied the phase transformations in *p*-dichlorobenzene by means of quadrupole resonance.

The Conference was organized by Prof. R. Freymann (Rennes) and Dr. J. Le Bot (St. Malo-Rennes), and was supported financially by French industry. The conference was made royally welcome by the Municipality of St. Malo. The publication of the report and preparation of preprints were undertaken again by Dr. G. J. Béné and the Geneva group.

The Colloque A.M.P.E.R.E. 1958 will be held in Paris during June. Information concerning the Colloque A.M.P.E.R.E. can be obtained from Prof. R. Freymann, University of Rennes, or from Dr. J. G. Powles, Physics Department, Queen Mary College, London, E.1.

J. G. Powles

THE THIRD LAW OF THERMODYNAMICS

THE "Year Book of the Physical Society, 1956", the second in the series, contains the texts of the fortieth Guthrie Lecture and the eleventh Holweck Lecture; the addresses delivered by the recipients of the thirty-second Duddell Medal and the eleventh Charles Vernon Boys Prize; abstracts of the discourses given at the fortieth Physical Society exhibition of scientific instruments and apparatus; obituary notices of fourteen fellows including Irene Joliot-Curie, A. O. Rankine, H. R. Robinson, S. Whitehead and R. W. Wood; and the report of the Council of the Society for 1955.

In his Guthrie Lecture which he delivered on March 13, 1956, the late Sir Francis Simon gives a historical and critical survey of the third law of thermodynamics. In 1906, in a paper entitled "On the Calculation of Chemical Equilibria from Thermal Measurements", W. Nernst enunciated his so-called Heat Theorem which has now become the third law, and although at first it was considered mainly as a means of predicting chemical equilibria and directly applicable only to condensed systems, its later formulation as the law of the unattainability of absolute zero, and its extension to gaseous systems, led to Nernst's claim that it was a law of general validity. However, subsequent investigations disclosed a number of notable discrepancies, and the law was rejected by many physicists. In 1927, Simon gave a new formulation of the law, which states that the entropy of all factors within a system that are in internal thermodynamic equilibrium disappears at absolute zero, and in this form the law covers all cases without exception. Sir Francis mentions that he was first a pupil, then a research assistant and finally a colleague of Nernst, and was thus close enough to obtain a very clear picture of what Nernst had in mind, but yet not so close as to be completely dominated by Nernst. In fact, some of the strongest opposition to Simon's new formulation of the third law came from Nernst himself. Turning to recent experimental developments, Sir Francis deals with spin systems, and indicates the various sub-systems which must exist within a substance, some of which are in internal equilibrium and lose their entropy at some low temperature, and others in which the disorder persists down to the lowest temperatures. Finally, he poses the question as to the present usefulness of the third law, and maintains that it has outlived most of its usefulness in the field for which it was originally intended, namely, chemical gas reactions, since the corresponding condensed phases may not be in internal thermodynamic equilibrium. Absolute zero of temperature is no longer a point of reference for the thermodynamic calculations in these cases, and we must take the quantum statistical expression for the entropy of the gas to find out whether the condensed phase at absolute zero is in perfect order or whether it has a frozen-in disorder. In low-temperature physics, however, the third law is a most important guide since most of the systems of interest to physicists are not liable to become frozen in. Moreover, those cases where apparent discrepancies with the third law have been discovered have led to a better understanding of many properties of the condensed phase.

The Holweck Lecture, entitled "The Diffusion of Visible Light by Cubic Crystals", was delivered by

Prof. J.-P. Mathieu. He describes how the diffusion, which is anisotropic even in cubic crystals, enables one to find the modes to which every observed line of the vibration spectrum belongs, and outlines some applications of the method to the study of crystal structure and the nature of order–disorder transformations. The early history of the travelling wave tube was the subject of the address given by R. Kompfner, the Duddell Medallist, and crystals of silver halides, by J. W. Mitchell, the Vernon Boys Prizeman. S. WEINTROUB

POLYESTER WAX

A NEW RIBBONING EMBEDDING MEDIUM FOR HISTOLOGY

By Dr. H. F. STEEDMAN

Department of Zoology, University of Glasgow

INVESTIGATION of synthetic waxes during the past ten years indicates that there are some which possess advantages over paraffin wax for histological purposes. Of more than fifty which were subjected to detailed examination 400 polyethylene glycol distearate (Anchor Chemical Co., Ltd., Manchester 11) proved to be the most suitable. To this was added cetyl alcohol as an extending agent, and the mixture is referred to as polyester wax. The amounts used are 400 polyethylene glycol distearate 99 gm., cetyl alcohol 1 gm.

This mixture has the following features :

(1) Melting point 37° C.
(2) Insoluble in cold water.
(3) Soluble in alcohols, ethers, esters, ketones, hydrocarbons, etc.
(4) Almost opaque.
(5) Circular, notched crystals.
(6) Easy sectioning, ribboning, and flattening of sections and ribbons.
(7) No electrification of ribbons during cutting.
(8) Good water tolerance.
(9) Flattening of sections or ribbons on solutions of stains such as methylene blue permits staining of sections through the wax, as with ester wax (ref. 1).
(10) Sections of 2 microns and more may be cut at a room temperature between 10° and 22° C.

The main advantage which this wax possesses over paraffin wax and ester wax[1,2] is its low melting point. This reduces hardening and shrinkage of tissues, as well as other heat-induced artefacts.

Associated with the use of low-temperature infiltration waxes are the two major problems of complete removal of the clearing agent or wax solvent from the specimen during its infiltration with wax, and of adhesion of tissue sections to microscope slides.

Infiltration. During infiltration it is essential that the wax solvent should be removed entirely from the specimen, and this usually takes place in two ways—by diffusion into the wax, and by evaporation. At 52° C. when xylene is used, as with paraffin wax, both processes operate simultaneously. When a non-volatile wax solvent is used, such as cedarwood oil, removal takes place by diffusion only. Such a process is slow and necessitates the use of several changes of wax.

When the melting point of the wax is as low as 37° C. both processes are greatly reduced in speed, because the decreased temperature leads to increased viscosity of the wax solvent or clearing agent, and hence to slower diffusion from the specimen. Heavy, non-volatile solvents such as cedarwood oil are therefore not recommended for use with polyester wax, unless mechanical stirring is employed during infiltration. Alcohols, ethers, and esters are recommended, or hydrocarbons such as xylene or ligroin for those who prefer them. A solution of 96 per cent ethyl alcohol and 4 per cent water is excellent.

Adhesion of sections. Tissues infiltrated with wax at 37° C. are not heat-denatured to the same extent as those infiltrated at 52° C. or above. Tissue sections cut in this wax must also be dried at low temperatures—18–25° C. As a consequence of this, sections cut in polyester wax, when taken down to water for staining, tend to wash off the microscope slide very easily, because the section proteins absorb water more readily, and because adhesives such as egg albumen have not been baked into a condition of relative hardness and insolubility, as is the case when they are dried at 52° C. All the known adhesives for tissue sections failed to prevent the loosening of polyester wax sections, and more than eighty new reagents for this purpose were investigated. Of these, amylo-pectin (Messrs. Brown and Polson, Ltd., Industrial Products Division, Trafford Park, Manchester 17) proved to be the most successful. It will stick sections to glass more firmly than any other medium, but when dissolved in water it breaks down and loses its adhesive properties after eight days. A preservative is therefore employed. The solution is made up as follows :

Amylopectin solution :
(1) Boil a litre of distilled water and add to it while still boiling 1·5 gm. Nipa ester No. 82121 (Nipa Laboratories, Ltd., Treforest Trading Estate, Pontypridd, Glam.). Stir until the ester is dissolved.
(2) Cool 200 ml. of this solution to room temperature and add 2 gm. of amylopectin. This will not dissolve but will lie as a white powder at the bottom of the beaker.
(3) Raise the 800 ml. to the boil and add slowly, with stirring, the 200 ml. containing the amylopectin. A bluish, opalescent suspension will be produced. Cool, and the reagent is ready for use. Always shake it before use, and do not filter.

The complete method of using polyester wax is as follows :

(1) Bring fixed material to 96 per cent ethyl alcohol, 4 per cent water; or bring to absolute alcohol, 'Cellosolve', or xylene as desired.
(2) Transfer the tissue either to a mixture of any of the above fluids and wax, or directly to pure wax. The infiltration time is approximately equal to that when using paraffin wax, plus one-third.
(3) Make a block as with paraffin wax. Do not immerse the molten wax in water, but leave to cool without further attention. It is not necessary to surround the block with cold water.
(4) Cut sections at the speed of paraffin wax sectioning—approximately 80–100 per min. Do not handle the block.
(5) Float the sections or ribbons on to the amylopectin solution given above, either on a microscope slide or in a dish.
(6) Flatten the sections by leaving them on the amylopectin solution for 5–10 min. at a room temperature of 18° C., or speed this process up by placing the slide with the sections on it upon a warm plate at 25° C. for about 30 sec.
(7) Drain the excess amylopectin solution off the slide and dry the sections overnight at room temperature or at about 25° C. As excess amylopectin will show as fine black dots under the microscope, the slide must be well drained before drying.
(8) From then on treat as paraffin wax sections.

Polyester wax tends to become softer after it has been continuously heated in an oven at 37° C. for several weeks.

It is considered that this wax could take the place of paraffin wax both for routine purposes and for research work. Its low melting point permits its use without expensive infiltration ovens, and for this reason histological practice might be brought within the reach of schools and colleges where it had not been possible previously for financial reasons.

It is hoped to publish a more detailed account elsewhere.

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AMINO-ACID SEQUENCE OF THE α-MELANOCYTE-STIMULATING HORMONE

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LERNER and Lee[1] have isolated two different highly active melanocyte-stimulating polypeptides from the posterior lobes of pig pituitary glands. The major active component (α-melanocyte-stimulating hormone) was shown to be a basic polypeptide with an isoelectric point at *p*H 10·5–11·0, while the other active component (β-melanocyte-stimulating hormone), a polypeptide with an acidic isoelectric point (*p*H 5·5), appears to be identical with the melanocyte-stimulating hormones isolated independently by Porath, Roos, Landgrebe and Mitchell[2], by Benfey and Purvis[3], and by Geschwind, Li and Barnafi[4].

The complete chemical structure of the melanocyte-stimulating hormone[2] corresponding to the β-melanocyte-stimulating hormone was elucidated by Harris and Roos[5]. It was shown to consist of eighteen amino-acid residues[5b] in a single peptide chain, and to contain a sequence of seven amino-acids which had previously been shown to occur in the corticotropins[6,7]. This revealed a chemical basis for the intrinsic melanocyte-stimulating activity[6,8] of the corticotropins. Geschwind, Li and Barnafi[4] have come to similar conclusions concerning the melanocyte-stimulating hormone which they have isolated from the pig pituitary.

Added in proof. Geschwind, Li and Barnafi have recently described (*J. Amer. Chem. Soc.*, 79, 1003; 1957) the isolation and structure of a β-type melanocyte-stimulating hormone from ox pituitaries, in which the glutamic acid residue in position 2 (β-MSH (pig), Fig. 1) is replaced by serine.

Structure of the α-melanocyte-stimulating hormone. The material used in the present investigation was prepared by Dr. Teh Lee according to a procedure which has already been described[1b].

Amino-acid composition, amino- and carboxyl-terminal groups. The amino-acid analysis of the α-form of melanocyte-stimulating hormone (we are indebted to Mr. M. W. Rees and Miss B. D. Worboys for this analysis) was determined by the procedure of Moore and Stein, and the following composition was deduced on the basis of minimum whole number molar ratios of the principal constituent amino-acids: Arg_1 Glu_1 Gly_1 His_1 Lys_1 Met_1 Phe_1 Pro_1 Ser_2 Try_1 Tyr_1 Val_1.

Smaller amounts (less than 0·2 mole) of aspartic acid, threonine, alanine and leucine were also found to be present in a 24-hr. acid hydrolysate of the preparation under investigation; but we decided to proceed on the assumption that these additional amino-acids were not integral constituents of α-melanocyte-stimulating hormone. This assumption was in fact verified when the amino-acid sequence had been determined, and it was then clear that the results of previous amino-acid analyses (quoted in ref. 1*b*) had led to erroneous conclusions concerning the amino-acid composition and molecular size of both the α- and β-melanocyte-stimulating hormones.

No N-terminal residue could be detected when the fluorodinitrobenzene[9] and modified[10] phenylisothiocyanate[11] methods were applied to α-melanocyte-stimulating hormone and no C-terminal residue could be revealed with carboxypeptidase[12].

Action of trypsin and chymotrypsin. α-Melanocyte-stimulating hormone (2 mgm.) was digested with trypsin (0·02 mgm.) at *p*H 8·2 and 30° for 30 min.; two 2-mgm. portions were also separately digested with chymotrypsin (0·02 mgm.) at *p*H 8·2 and 30° for 30 min. and 16 hr. respectively. The three reaction mixtures were submitted to ionophoresis on paper in a pyridine–acetic acid buffer (*p*H 6·5) for 90 min. at 40 V./cm. The resulting peptide fragments were located on guide strips with ninhydrin; peptides containing tryptophan, tyrosine and histidine residues were separately located by specific colour reactions, and after elution with 5 per cent acetic acid, each peptide component was hydrolysed (6 *N* hydrochloric acid, 18 hr., 105°) and analysed for its constituent amino-acids by chromatography on paper. The amino-acid compositions of the peptide fragments derived from α-melanocyte-stimulating hormone are given in Table 1.

Elucidation of amino-acid sequence. Peptide C_1 did not react with ninhydrin but gave serine and tyrosine after hydrolysis with acid; tyrosine was shown to be C-terminal[12] and the residual serine derivative, which did not react with ninhydrin, gave free serine after hydrolysis with acid. C_1 is thus an amino-substituted derivative of Ser.Tyr. The C-terminal residue of T_1 is arginine (in accordance with the

Table 1

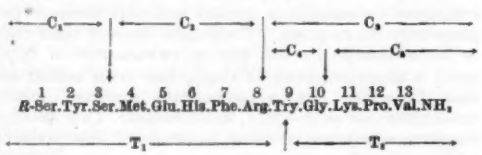
Peptide	Amino-acid composition
Trypsin, T_1	(Ser$_1$, Tyr, Met, Glu, His, Phe, Arg)
Chymotrypsin, C_1	(Ser, Tyr)
,, C_2	(Ser,Met,Glu,His,Phe)
,, C_3	(Arg, Try, Gly, Lys, Pro, Val)
Trypsin, T_2	(Try, Gly, Lys, Pro, Val)
Chymotrypsin, C_4	(Arg, Try)
,, C_5	(Gly, Lys, Pro, Val)

* Scientific Staff, Medical Research Council.

specificity of trypsin) and phenylalanine was shown to be C-terminal in C_2 by means of carboxypeptidase. From a comparison of T_1, C_1 and C_2, it is seen that C_1 and C_2 are part of the T_1 sequence, which in turn must form the N-terminal sequence, Ser.Tyr.(Ser, Met, Glu, His).Phe.Arg, in the structure of α-melanocyte-stimulating hormone. By means of the modified phenylisothiocyanate method[10], the phenylthiohydantoin derivatives of serine, methionine and glutamic acid were successively released from C_2, thereby establishing the N-terminal sequence in α-melanocyte-stimulating hormone R-Ser.Tyr.Ser.Met.Glu.His.Phe.Arg.

By the prolonged action of chymotrypsin, C_2 gave equimolar amounts of C_4 and C_5. Like T_2, both C_2 and C_5 were found to be unusually basic as judged by their mobilities during ionophoresis at *p*H 6·5. It could be inferred that the COOH group of the C-terminal residue in all three peptides is not free, and this idea received additional support when it was found that (as in α-melanocyte-stimulating hormone) the three peptide fragments T_2, C_2 and C_5 were not susceptible to the action of carboxypeptidase. Clearly T_2, C_2 and C_5 form the C-terminal sequence, Arg.Try.(Gly, Lys, Pro, Val), in α-melanocyte-stimulating hormone. The structure of C_5 was determined by partial acid hydrolysis (12 *N* hydrochloric acid, 5 days, 37°). In this way the peptide fragments Gly.Lys, Gly.Lys.Pro, Lys.Pro, and Pro.Val were identified; one mole of ammonia was also obtained. This established the sequence in C_5 to be Gly.Lys.Pro.Val.NH_2.

The complete amino-acid sequence of α-melanocyte-stimulating hormone is therefore established as follows:



The α-melanocyte-stimulating hormone is shown to be an N-substituted tridecapeptide amide, and its amino-acid sequence is identical with the N-terminal tridecapeptide sequence of the corticotropins[6,7]. However, the amino group of the N-terminal serine of the hormone is substituted by an as yet unidentified group, while the C-terminal residue, valine, occurs as the amide.

The structures of the two melanocyte-stimulating hormones (α and β), together with the related N-terminal tridecapeptide sequence of corticotropin, are illustrated in Fig. 1. As shown, the heptapeptide Met.Glu.His.Phe.Arg.Try.Gly occurs in all three molecules. If in β-melanocyte-stimulating hormone the lysine in position 6 were interchanged with the serine in position 14, then the sequence of identity would extend to eleven amino-acids.

The N-terminal positions in the three molecules are, however, significantly different. Thus, although the sequence Ser.Tyr.Ser is N-terminal in both corticotropin and the α-melanocyte-stimulating hormone, the amino- (and possibly also the adjacent hydroxyl) group of the terminal serine is blocked in the latter. In β-melanocyte-stimulating hormone, where this particular sequence does not occur, it must be assumed that the unrelated Asp.Glu.Gly.Pro structure fulfils the same function as the N-substituted serine moiety in α-melanocyte-stimulating hormone. It is clear that a free N-terminal serine is not an essential constituent of a highly active melanocyte-stimulating peptide; moreover, corticotropin, which does contain a free terminal serine, has relatively low activity (1 per cent[6,8]) as a melanocyte stimulator. This suggests that the free N-terminal serine, which has been shown[12] to be essential for adrenocorticotropic hormone activity, is at the same time responsible for the diminished melanocyte-stimulating activity of corticotropin.

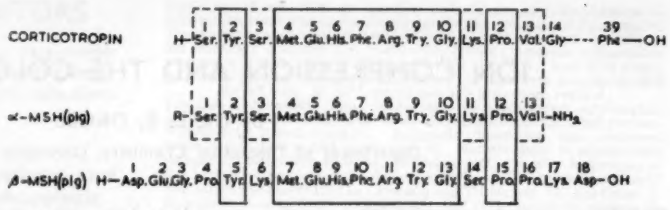


Fig. 1. Amino-acid sequences of α- and β-melanocyte stimulating hormones and corticotropin from pig pituitary glands

It is therefore highly significant that, when the terminal serine in corticotropin is modified, as in the periodate-treated hormone[13], or removed, as in the alkali-treated hormone[6], the loss of adrenocorticotropic hormone activity which occurs is in both cases accompanied by a significant increase in melanocyte-stimulating activity (ref. 6, and unpublished work by Dixon, H. B. F., and Lerner, A. B.). These results show that corticotropin can be changed into a predominantly melanocyte-stimulating substance and suggest that the terminal serine residue plays an important part in determining which of the two biological properties shall predominate. Nevertheless it seems probable that the essential minimum structural requirements for melanocyte-stimulating activity are to be found in the common sequence, Met.Glu.His.Phe.Arg.Try.Gly, since the positions adjacent to it (that is, 6 and 14 in β-melanocyte-stimulating hormone, 3 and 11 in α-melanocyte-stimulating hormone) can be occupied by either lysine or serine without effect on the biological potencies of the two substances.

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ION COMPRESSION AND THE COLOUR OF RUBY

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THE spectra of many transition-metal compounds have been interpreted successfully by means of crystal-field (ligand-field) theory. The hydrates have received more attention than any other class of compound, and the band assignments for their spectra are fairly complete[1]. If the spectra of transition-metal ions dissolved in glasses or in other oxide materials[2] are compared with those of the hydrated ions, the correspondence between them is found to be very close, provided that the metal ion is octahedrally co-ordinated in the host lattice. For trivalent ions in glasses the only observed differences are small shifts of the absorption bands to longer wavelengths, corresponding to a decrease of 5–15 per cent in Δ, the fundamental crystal-field splitting of the d-orbitals. In the case of the chromium ion (Cr^{3+}), the hydrate has band maxima at 17,400 cm.$^{-1}$ and 24,700 cm.$^{-1}$, corresponding to the $^4A_{2g} \rightarrow {}^4T_{2g}$ and $^4A_{2g} \rightarrow {}^4T_{1g}$ transitions, respectively[1]. In glasses these maxima are displaced to 15,400 cm.$^{-1}$ and 22,200 cm.$^{-1}$. The green colour of hydrated chromic salts, chromic oxide and chromic ion in most oxide lattices is due to these two bands, particularly to the one with its maximum near 16,000 cm.$^{-1}$.

The optical properties of the ruby, which consists of a small quantity of Cr_2O_3 dissolved in an Al_2O_3 matrix, have been regarded as anomalous. One would expect that solutions of chromium ions in the corundum lattice of Al_2O_3 would be green, and in fact solutions containing a large quantity of Cr_2O_3 dissolved in α-Al_2O_3 or any quantity of Cr_2O_3 dissolved in β-Al_2O_3 are green in colour. But rubies are red. Furthermore, red solutions of Cr_2O_3 become green on heating but revert to their original colour on cooling[3]. Explanations of these facts based on the presence of an oxidation state of chromium other than three have been excluded by magnetic and other studies. The suggestion that the change from red to green observed as the concentration of Cr_2O_3 is increased is connected with the antiferromagnetic exchange coupling which undoubtedly occurs in Cr_2O_3 is excluded by the reversion of green solutions to red on cooling.

The simplest remaining possibilities are that the chromium ions are not octahedrally co-ordinated or that although they are octahedrally co-ordinated they are subjected to an anomalously large crystal field. We shall show that an interpretation based on the second of these hypotheses can be justified by intuitive arguments and is consistent with all the available experimental evidence. The first hypothesis is without any support, since the corundum structure which involves octahedral co-ordination of the metal ions is adopted both by α-Al_2O_3 and by Cr_2O_3.

The red colour of ruby is due to an absorption band the maximum[4] of which is at about 19,000 cm.$^{-1}$. Thus, according to our interpretation, the crystal-field parameter Δ in ruby has increased by 20 per cent relative to that in other oxide materials. In the electrostatic theory, Δ is proportional to R^{-5} where R is the metal-anion distance, so that a reduction of 20 per cent in Δ corresponds to a reduction of the metal–oxygen distance by 4 per cent. Taking the radius of the chromium ion as 0·65 A. and that of the oxygen ion as 1·40 A., we find a normal Cr–O distance of 2·05 A., so that a shortening of the Cr–O distance by 0·08 A. would be sufficient to account for the observed difference in colour. While we do not believe that the crystal-field theory can give accurate absolute values for Δ in terms of molecular dimensions, we nevertheless believe the above estimate to be of the right order of magnitude.

The radius of the aluminium ion (Al^{3+}) is 0·50 A., that is, substantially smaller than the radius of the chromium ion (Cr^{3+}). It therefore seems certain that if aluminium ions were replaced by chromium ions in a solid lattice without changing the positions of the neighbouring anions an enormous repulsion energy would result. In practice, this would be decreased by the relaxation of the host lattice. The final position of the anions, however, would not correspond to the normal ionic radius of the impurity ion but to some intermediate radius between that of the host and the impurity. The above very rough calculation suggests that in ruby this radius is about 0·57 A., which by chance is just the mean of the ionic radii of aluminium and chromium.

Thilo and co-workers[3] have shown that at room temperature Al_2O_3–Cr_2O_3 solutions containing up to 8 atom-per cent Cr_2O_3 are red in colour, but that solutions containing a greater amount become progressively more green. They also showed that there is little change in the lattice parameters of Al_2O_3 until 8 atom-per cent of Cr_2O_3 has been added and that then the lattice parameters increase linearly until those for pure Cr_2O_3 are reached. This strongly supports our interpretation in terms of 'compression' of the chromium ion.

It was also noted that the temperature at which the transition from red to green occurred decreased with the concentration of chromium ions. This, presumably, is because the relaxation of the lattice takes place more easily when a larger amount of chromium ions is present.

It has been reported[3] that certain Cr^{3+}—Al^{3+} spinels are also red when the chromium ion concentration is sufficiently low, but green otherwise. The same mechanism is presumably at work in these cases as in ruby. It seems possible that the colour of chromium ions in oxide matrices may provide a general method for determining the 'pressure' to which the ion is subjected. Certainly a red colour is obtained in the 'hard' corundum and spinel lattices and a green one in the 'softer' glasses.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Formation of Erythrose-4-phosphate and Acetyl Phosphate by a Phosphorolytic Cleavage of Fructose-6-phosphate

SYNTHESIS of cellulose from glucose by washed cells of *Acetobacter xylinum* is not inhibited by iodoacetate[1]. It would therefore appear that the energy required for the formation of cellulose from glucose in *A. xylinum* may be generated via a pathway which does not involve the iodoacetate-sensitive glyceraldehyde-3-phosphate dehydrogenase of this organism. In an attempt to find such an energy-yielding reaction, crude extracts of a 'celluloseless' mutant[2] of *A. xylinum* were employed. Although the enzyme-catalysed reaction described below was also demonstrable in the wild type *A. xylinum*, the mutant was used because of its relatively abundant growth in shake cultures.

The micro-organisms were grown at 30° with continuous shaking for 20–24 hr. The cells were harvested by centrifugation and washed several times with distilled water. Extracts were prepared in 0·05 *M* histidine buffer *p*H 6·5 containing 0·5 per cent potassium chloride with the aid of a Nossal shaker[3]. On incubating a crude extract thus obtained with glucose-6-phosphate and inorganic orthophosphate in the presence of iodoacetate, an uptake of inorganic orthophosphate was observed. The results presented in Table 1 indicated that inorganic orthophosphate was converted to an acid-labile acyl phosphate which could be linked to a hexose phosphorylation system consisting of adenosine-5-phosphate, mannose and hexokinase. To study the reaction responsible for the uptake of inorganic phosphate more extensively, the enzyme system was purified about 15-fold. Incubation of fructose-6-phosphate and inorganic orthophosphate with the purified protein fraction resulted in the formation of acetyl phosphate and erythrose-4-phosphate simultaneously with the uptake of inorganic orthophosphate.

Table 1. UPTAKE OF INORGANIC PHOSPHATE BY AN EXTRACT OF *A. xylinum* MUTANT IN THE PRESENCE OF GLUCOSE-6-PHOSPHATE. The complete system contained in a final volume of 1·2 ml. the following reagents: 7·5 μmoles of inorganic phosphate; 15 μmoles of sodium fluoride; 7 μmoles glucose-6-phosphate; 3 μmoles of iodoacetate; 5 μmoles magnesium chloride; 40 μmoles histidine buffer, *p*H 5·9; bacterial extract (3·5 mgm. protein); and a hexose phosphorylation system consisting of 10 μmoles of mannose; 2·5 μmoles of adenosine-5-phosphate; 0·25 μmole of adenosine triphosphate; and 46 units of hexokinase (ref. 6). The mixture was incubated for 30 min. at 30°

	Δ Pi I* (μmoles)	Δ Pi II† (μmoles)	Hydroxamic acid‡ (μmoles)
Complete system	−3·0	−2·9	1·0
Glucose-6-phosphate omitted	0·0	—	—
Hexose phosphorylation system omitted	0·0	−2·1	2·8
Glucose-6-phosphate and hexose phosphorylation system omitted	0·0	0·4	0·4

* Pi I determined in presence of 0·5 *N* sulphuric acid according to Fiske and Subbarow (ref. 7).
† Pi II determined at *p*H 4·0, according to Lowry and Lopez (ref. 8).
‡ Hydroxylamine was added at the end of the incubation period and hydroxamic acid formation determined according to Lipmann and Tuttle (ref. 9).

Table 2. FORMATION OF ACETYL PHOSPHATE AND ERYTHROSE-4-PHOSPHATE FROM FRUCTOSE-6-PHOSPHATE AND INORGANIC PHOSPHATE. The complete system contained in a final volume of 0·8 ml. the following reagents: 8 μmoles of fructose-6-phosphate; 8 μmoles of inorganic phosphate; 56 μmoles of histidine buffer, *p*H 5·5; and 0·36 mgm. protein of purified enzyme preparation. The mixtures were incubated for 40 min. at 30°, except for the zero time control.
Fructose-6-phosphate was determined by measuring triphosphopyridine nucleotide reduction with phosphohexoisomerase and glucose-6-phosphate dehydrogenase. Inorganic phosphate was measured according to Lowry and Lopez (ref. 8). Measurement of acetate was carried out according to Rose and Ochoa (ref. 10) after hydrolysis of the acetyl phosphate, and determination of the hydroxamic acid was carried out according to Lipmann and Tuttle (ref. 9). Erythrose-4-phosphate was assayed enzymatically (ref. 11) (figures in column I) and by a colorimetric method for tetroses according to Dische (personal communication) (figures in column II)

System	Δ Fructose-6-phosphate (μmoles)	Δ Pi (μmoles)	Acetyl phosphate as acetate (μmoles)	Acetyl phosphate as hydroxamic acid* (μmoles)	Erythrose-4-phosphate I (μmoles)	Erythrose-4-phosphate II (μmoles)
Complete	−3·7	−3·3	3·5	3·2	2·6	2·7
Minus Pi	—	0·2	0·4	0·4	0·2	0·2
Complete, 0 time	−0·1	0·2	0·0	0·0	0·1	0·0

* The hydroxamic acid was identified as acethydroxamic acid by paper chromatography following the method of Stadtman and Barker (ref. 12).

Studies on the stoichiometry of the reaction, as shown in an experiment in Table 2, suggest that the following reaction is catalysed by the enzyme preparation:

Fructose-6-phosphate + inorganic phosphate → acetyl phosphate + erythrose-4-phosphate

With xylulose-5-phosphate and inorganic orthophosphate as substrates, glyceraldehyde-3-phosphate and acetyl phosphate (measured as hydroxamic acid) were formed in almost equivalent amounts. An enzyme which catalyses such a cleavage of xylulose-5-phosphate but does not react with fructose-6-phosphate has recently been obtained from *Lactobacillus pentosus* grown on pentose[4]. With fructose-6-phosphate as substrate, the purified enzyme preparation from *A. xylinum* has a specific activity of 32 μmoles hydroxamic acid formed/mgm. protein/hr. at 30°. No activity, or less than 10 per cent of that with fructose-6-phosphate, was detected with the following compounds tested as substrates: fructose, fructose diphosphate, sedoheptulose-7-phosphate, hydroxypyruvate, pyruvate, dihydroxyacetone phosphate, glucose-6-phosphate, ribose-5-phosphate and erythrose-4-phosphate. The enzyme activity was markedly diminished by dialysis at an alkaline *p*H and partially restored by the addition of magnesium ions and thiamine pyrophosphate.

Although formation of acetate from hexose via triose phosphate formed in the pentose phosphate cycle can be accomplished by *A. xylinum*[5], the direct formation of acetyl phosphate from fructose-6-phosphate described in this communication might be visualized as a 'short-circuit' pathway to the two-carbon level. The substrate-level phosphorylation inherent in this reaction may serve to generate adenosine triphosphate with the aid of acetokinase which has been shown to be present in crude extracts of the cells. As shown in the following equations, one molecule of fructose-6-phosphate may yield three molecules of acetyl phosphate by the action of the phosphorolytic cleavage enzyme in conjunction with enzymes of the pentose phosphate cycle:

Fructose-6-P + Pi → acetyl-P + erythrose-4-P
Erythrose-4-P + fructose-6-P → sedoheptulose-7-P + glyceraldehyde-3-P → ribose-5-P + xylulose-5-P
Ribose-5-P → xylulose-5-P
2 Xylulose-5-P + 2 Pi → 2 acetyl-P + glyceraldehyde-3-P
2 Glyceraldehyde-3-P → fructose-1:6-di-P → fructose-6-P + Pi

Sum: Fructose-6-P + 2 Pi → 3 acetyl-P
3 Acetyl-P + 3 adenosine diphosphate → 3 adenosine triphosphate + 3 acetate

Thus, with the aid of acetokinase, three molecules of adenosine triphosphate would be formed, representing a net formation of two molecules of adenosine triphosphate from two of adenosine diphosphate per mole of glucose, an efficiency comparable to that of glycolysis. The acetyl phosphate may alternatively be metabolized via the citric acid cycle[1].

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The Free Energy of Hydrolysis of Adenosine Triphosphoric Acid

During the past decade, the value of the energy of adenosine triphosphate breakdown has several times been subject to revision. The more precise, though indirect, calculations[1] resulted in lower values (7–9 kcal./mol.) than the earlier results (11–13 kcal./mol.).

We have tried to determine the free energy of hydrolysis of adenosine triphosphate by establishing the equilibrium constant of the hexokinase reaction, using as a tracer the radioactive isotope of phosphorus:

Glucose-6-phosphate* + ADP ⇌ glucose + ATP*

The reaction mixture consisted of adenosine diphosphate, glucose-6-phosphate, labelled with radioactive phosphorus (specific activity 150–460 counts/min./μgm.), magnesium ions, yeast hexokinase and glycine buffer (*p*H 7·25).

Hexokinase prepared according to the Meyerhof procedure contained no admixture of phosphoglucomutase or myokinase. The adenosine diphosphate was free of any apparent traces of the triphosphate. The mixture was incubated in a water-bath at 37° C. for 3–6 hr. After inactivation of the enzyme by trichloracetic acid, the triphosphate synthesized was determined by its radioactivity. A strictly measured amount of non-radioactive adenosine triphosphate was added to the mixture as a carrier. The usual procedures were employed for the isolation of adenosine triphosphate and for purifying it of any trace of radioactive glucose-6-phosphate. As a criterion of the purity of the adenosine triphosphate, control experiments were performed in exactly the same conditions, but with hexokinase previously inactivated by boiling.

The amount of radioactive adenosine triphosphate was calculated from the quantity of triphosphate added as carrier and the specific activity of the portion of it isolated. The concentration of the glucose in equilibrium was considered to be equal to the concentration of adenosine triphosphate. The equilibrium constant of the hexokinase reaction (K) and the change of the free energy were calculated by the equation:

$$K = \frac{[\text{glucose-6-phosphate}]\,[\text{ADP}]}{[\text{glucose}]\,[\text{ATP}]};\ \Delta F^{\circ} = -RT\ln K$$

The hydrolytic breakdown of adenosine triphosphate can be represented as the sum of the hexokinase reaction and the hydrolysis of glucose-6-phosphate:

$$\text{glucose} + \text{ATP} \rightleftharpoons \text{glucose-6-phosphate} + \text{ADP};\ \Delta F^{\circ}_{1}\ (1)$$

$$\frac{\text{glucose-6-phosphate} + \text{H}_2\text{O} \rightleftharpoons \text{glucose} + \text{phosphate}}{(1+2)\,\text{ATP} + \text{H}_2\text{O} \rightleftharpoons \text{ADP} + \text{phosphate};\ \Delta F^{\circ}_{1+2}};\ \Delta F^{\circ}_{2}\quad (2)$$

Then the energy of hydrolysis of adenosine triphosphate can be determined as the sum of ΔF°_{1} and ΔF°_{2}:

$\Delta F^{\circ}_{1+2} = \Delta F^{\circ}_{1} + \Delta F^{\circ}_{2}$, where ΔF°_{2} is $-2{\cdot}45$ kcal. per mol. (ref. 2).

The results of experiments are given in Table 1.

The mean value of the free-energy change of the hexokinase reaction, according to the results in Table 1, is $-3{\cdot}2$ kcal. per mole, and the mean free energy of hydrolysis of adenosine triphosphate is $-5{\cdot}6$ kcal. per mole. There are reasons for considering the lower values of the equilibrium constant of hexokinase reaction as the most reliable.

Table 1. Equilibrium Constant Data of Hexokinase Reaction and ΔF° Values

Exp. No.	ADP (m.moles)	Glucose-6-phosphate (m.moles)	Specific activity of glucose-6-phosphate (counts/min./μgm.)	Duration of incubation (hr.)	Amount of ATP carrier (mgm.)	Amount of synthesized ATP (m.moles)	Equilibrium constant of hexokinase reaction (K)	ΔF° of hexokinase reaction (kcal./mole)	ΔF° of ATP hydrolysis (kcal./mole)
1	0·126	0·185	238	5·5	16·45	0·0040	1·380	−4·4	−6·85
2	0·124	0·193	147	3·0	16·63	0·0080	0·335	−3·5	−5·95
3	0·135	0·132	305	5·5	12·71	0·0087	0·204	−3·2	−5·65
4	0·124	0·193	147	5·0	16·63	0·0107	0·180	−3·2	−5·65
5	0·138	0·145	248	3·0	19·50	0·0120	0·116	−2·9	−5·35
6	0·118	0·193	461	2·5	11·80	0·0130	0·112	−2·9	−5·35
7	0·109	0·142	268	6·0	14·31	0·0135	0·073	−2·6	−5·05

The order of values obtained is in accordance with the new results[3] for the heat of hydrolysis of adenosine triphosphate, which is given as − 4·7 kcal. per mole, instead of the previously accepted value of − 12 kcal. per mole. It is nearly equal to the heat of hydrolysis of pyrophosphate and trimetaphosphate (− 5·8 and − 6·2 kcal. per mole of phosphate anhydride bond).

Under physiological conditions, the phosphate bond-energy of adenosine triphosphate will change, depending on concentrations of adenosine tri- and di-phosphate and inorganic phosphate, and will be considerably higher. Thus, if we accept the concentration of phosphoric acid as 0·01 *M* (which is usually the case in tissues) and that of adenosine triphosphate as the same as that of the diphosphate, it would be − 8·4 kcal.

Hence, in spite of the lower free-energy of adenosine triphosphate hydrolysis under standard conditions, this compound does not lose its biological significance as a universal accumulator of chemical energy.

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Blood Anticoagulant Activity of Sulphated Ovular Mucins of Amphibians

The mucin constituting the gelatinous layer which envelops the eggs of *Bufo bufo*, if digested with papain and then sulphated, shows a marked anticoagulant activity on the fibrinogen and the whole blood plasma[1]. A similar anticoagulant activity has now been shown by the ovular mucins of other species of amphibians, sulphated without any previous proteolysis.

The ovular mucins of *Discoglossus pictus*, axolotl and *Bufo bufo*, removed from the eggs either by hand or by treatment with sodium thioglycolate[2], were lyophilized, desiccated *in vacuo* over phosphorus pentoxide, and sulphated with chlorosulphonic acid (0·7 ml. per gm. of dry substance) for 12 hr. at − 16° C. The sulphated derivatives were neutralized, dialysed and filtered; no further purification was attempted.

The anticoagulant activity has been determined by the prolongation of the coagulation times of fibrinogen added to thrombin, and of oxalated bovine plasma after recalcification. The determinations were carried out as follows.

(1) *Fibrinogen*. 0·1 ml. of sulphated mucin solution was mixed with 0·5 ml. of a 0·5 per cent solution of fibrinogen (Bovine Plasma Fraction I, Armour Co.) in saline, and 0·1 ml. of a 0·1 per cent solution of Trombasi Roussel (a powder extracted from the blood plasma, and containing thrombin) was added. The coagulation times at 37° C. were determined, as well as those of the controls (0·1 ml. of distilled water instead of the mucin) and those given in the presence of a 0·0001 per cent solution of standard heparin (100 units per mgm.).

Table 1

	Concentration (μgm./ml.)	Coagulation times	
		Fibrinogen	Plasma
Controls		4 min. 34 sec.	7 min. 10 sec.
Heparin	1	6 min. 18 sec.	10 min. 35 sec.
Discoglossus	2·5	6 min. 20 sec.	—
	60	—	10 min. 28 sec.
Axolotl	9	6 min. 10 sec.	—
	100	—	10 min. 30 sec.
Bufo bufo	2·5 — 25	6 min. 20 sec.	—
		—	10 min. 22 sec.

(2) *Whole plasma*. 0·5 ml. of oxalated bovine plasma (9 parts of blood and 1 part of 0·1 *M* neutral potassium oxalate) was recalcified with 0·1 ml. of 2 per cent calcium chloride, and mixed with 0·1 ml. of sulphated mucin solution, or distilled water, or 0·0001 per cent standard heparin solution. The coagulation times were determined at room temperature (about 18° C.).

The results are summarized in Table 1, which only gives the results for concentrations of mucins showing approximately the same anticoagulant activity as 0·0001 per cent heparin, that is, prolonging the coagulation time of fibrinogen by about 40 per cent, and that of plasma by about 50 per cent. The results in Table 1 are the averages of sixteen determinations for fibrinogen, and of nine for the plasma.

From these results, the anticoagulant activities of the sulphated mucins could be expressed in heparin units as in Table 2.

Table 2. Anticoagulant Activity in Heparin Units

Mucin	Fibrinogen	Plasma
Discoglossus	40	1·5
Axolotl	10	1
Bufo bufo	40	4

The anticoagulant activity induced by sulphation is probably due to the sulphamic groups arising in the esterification with sulphuric acid of the hexosamines present in the mucin substance[1]. The much lower activity for the whole plasma than that for fibrinogen, in respect to the heparin, may depend on the inability of the sulphated mucins to combine with the plasma fractions which activate heparin.

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Antigenicity of Antibodies of the Same Species

In previous papers[1] rare human sera were described which possess the ability to agglutinate human red cells sensitized with incomplete isoantibodies. The possible application of such sera in blood group laboratories was stressed. Based on the absorption experiments, the opinion was expressed that the agglutinating factor contained in these sera is an 'anti-antibody', which reacts with human immune globulins denatured in serological reaction.

Table 1. Absorption of Rabbit 'Anti-antibodies' produced on Isostimulation

Titres of the two kinds of unabsorbed sera against sensitized sheep red-cells, 1 : 256.

Serum absorbed by		Agglutination titre* of the sensitized sheep red-cells by the 'anti-antibodies' stimulated by	
		Proteus antibody	*Escherichia* antibody
Proteus bacilli	Unchanged	256	256
	Agglutinated by rabbit *Proteus* antibody	8	256
Escherichia bacilli	Unchanged	256	256
	Agglutinated by rabbit *Escherichia* antibody	256	1
Sheep red cell stromata	Unchanged	256	256
	Sensitized by rabbit anti-sheep hæmolysin	< 2	16

* The agglutination titre given is the reciprocal of the last serum dilution which gave a marked agglutination.

To obtain further evidence for this hypothesis it had to be shown that the immune globulins of the individual's own species become antigenic after denaturation in serological reaction. This proof was obtained in animal experiments.

Isostimulation. Rabbits were injected intravenously with *Escherichia* and *Proteus* bacilli agglutinated by a corresponding rabbit immune serum. Ten to twelve intravenous injections were performed at weekly intervals. The sera of all animals stimulated in such a way agglutinated sheep cells sensitized with rabbit anti-sheep hæmolysin. The most potent serum reacted up to the dilution of 1 : 512.

The agglutination of the sensitized sheep cells could be eliminated or significantly diminished by absorption of the sera with sheep red-cell stromata sensitized with rabbit anti-sheep hæmolysin. As is to be seen from Table 1, *Escherichia* bacilli agglutinated by the *Escherichia* antibody only eliminate 'anti-antibody' obtained by stimulation performed with *Escherichia* antibody, and do not absorb 'anti-antibody' obtained by stimulation performed with *Proteus* antibody. Similarly, only the homologous and not the heterologous 'anti-antibody' was absorbed by the *Proteus* bacilli agglutinated by *Proteus* antibody.

Autostimulation. Rabbits were injected at weekly intervals with leucocytes obtained from a peritoneal effusion produced artificially in guinea pigs. During one month intravenous, and during four months intraperitoneal, injections were given. The immune serum, besides reaction with guinea pig leucocytes, agglutinated also sheep red-cells sensitized with rabbit hæmolysin. The titre of this reaction was 1 : 512.

The experiments on isostimulation have shown that immune globulins of an individual's own species become antigenic when they are denatured in serological reaction. The 'anti-antibody' produced in this way can be easily detected by the agglutination of red cells sensitized with antibody. It was rather surprising to us that 'anti-antibody' against *Proteus* antibody and that against *Escherichia* antibody are not cross-absorbed. Perhaps this indicates differences in antigenic structure of rabbit antibodies of different specificity. The rabbit hæmolysin reacting with both 'anti-antibodies' must possess some antigenic properties of both *Proteus* and *Escherichia* antibodies.

Experiments on autostimulation showed that the immune globulins of the individual's own body may become antigenic. On the immunization with leucocytes, the first antibody to appear was leucocyte antibody. Further injections of leucocytes caused the *in vivo* reaction between these cells and the corresponding antibody. In this reaction the antibody was presumably denatured and stimulated the production of an 'anti-antibody'.

In connexion with the experiments described, the paper by Coombs and Coombs[2] in which the antigenicity of the individual's own complement was shown was of particular interest.

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Rh Antigens and Immunological Tolerance

The discovery of the phenomenon of immunological tolerance has raised the possibility that the nature of a mother's Rh blood-type may affect the reactivity of her children towards Rh antigens[1–3]. The simplest possibility is that the Rh-negative women born of Rh-positive (as opposed to Rh-negative) mothers should be relatively tolerant of Rh antigens as a result of an exposure to those antigens in fœtal life; and this tolerance might reveal itself by their being less readily immunized against the Rh antigens of an Rh-positive fœtus, or by their bearing fewer children afflicted by hæmolytic disease.

Two independent series of observations[1,3] have shown that the Rh type of the mothers of those Rh-negative women whose children develop hæmolytic disease does not depart significantly from normal expectation. On the other hand, the data of Owen *et al.*[3] suggest that the Rh-negative daughters of Rh-positive women may have relative tolerance if the presence or absence of antibodies in sera is used as the criterion of tolerance. We have recently been able to determine the Rh-status of the mothers of 173 Rh-negative women who developed Rh antibodies in their sera and who gave birth to children afflicted with hæmolytic disease of various degrees of severity. Our findings are summarized in Table 1, in which the actual distribution of the Rh blood-types of the mothers—that is, of the grandmothers of the affected children—is compared with normal expectation (calculated from the data given by Booth, Dunsford, Grant and Murray[1]). The results show a relative

Table 1. Rh-Status of Mothers of Immunized Rh-negative Women

	Rh + ve	Rh − ve	Total
Observed (No.)	91	82	173
(per cent)	52·6	47·4	100
Expected (No.)	102·04	70·96	173
(per cent)	58·98	41·02	100

$\chi^2 = 2{\cdot}912$ for 1 degree of freedom; p lies between 0·05 and 0·10.

Table 2. Severity of Disease in First Affected Child

Rh group of grandmother		Mild	Severe recovered	Severe died	Still-born	Total
Rh+ve	(No.)	24	35	16	16	91
	(per cent)	26·4	38·5	17·6	17·6	100
Rh−ve	(No.)	25	27	11	19	82
	(per cent)	30·5	32·9	13·3	23·2	100
Unknown	(No.)	76	82	45	38	241
	(per cent)	31·5	34·0	18·7	15·8	100
Total	(No.)	125	144	72	73	414
	(per cent)	30·2	34·8	17·4	17·7	100

excess of Rh-negative mothers—a departure in the direction which the hypothesis of tolerance suggests, but one which falls short of the accepted level of significance ($0{\cdot}05 < p < 0{\cdot}10$).

We next investigated the possibility that tolerance might be reflected in the severity of the disease in the affected children, which might vary with the Rh blood-type of their grandmothers. The severity of hæmolytic disease in the first affected child was classified under four headings: (1) mild disease, infant not transfused; (2) severe disease, infant transfused and recovered; (3) severe disease, infant transfused but died; and (4) infant stillborn. The results are shown in Table 2, from which it is clear that, in our sample, the severity of the disease in the affected children was not correlated with the Rh blood-group of the grandmother.

Lastly, we investigated the mean Rh antibody titres in women with Rh-positive and Rh-negative mothers respectively, and these are shown in Table 3. The mean antibody titre of women with Rh-positive mothers is actually somewhat higher than the mean antibody titre of women with Rh-negative mothers, but this may be due to chance.

Table 3. Mean Titres of Immunized Rh-negative Women

Rh group of grandmother	Mean interval in months since last exposure of mother to Rh (D) antigen	Mean titre of incomplete anti-D antibody at time of testing of mother
Rh+ve	30·8	355
Rh−ve	25·0	267

These results support and extend previous investigations[1,2] showing that an infant's likelihood of suffering from hæmolytic disease is not correlated with the Rh blood-type of its maternal grandmother. They also suggest, but do not prove, that the chances of Rh-negative women being immunized by Rh antigens are similarly independent of embryonic exposure to the antigens. On the other hand, two problems—(1) the kind of antibody, and (2) the number of pregnancies required to produce immunization in Rh-negative women born of Rh-positive or of Rh-negative mothers—need further investigation. Owen and his colleagues[2,3] have given evidence which suggests (*a*) that Rh-negative women who develop Rh antibody in a first, second or third pregnancy but whose babies do not develop clinically recognized hæmolytic disease are, in a disproportionate number of cases, the daughters of Rh-negative mothers; and (*b*) that the Rh-negative women who do not develop an anti-Rh antibody in their first three Rh-positive pregnancies are, more often than chance would suggest, the daughters of Rh-positive women. The present study does not test the interpretation outlined under (*a*) and (*b*), suggested by Owen and his colleagues.

It is possible that, in some instances, an Rh-negative woman born of an Rh-positive mother may have acquired some tolerance to the Rh antigens. However, the evidence on the whole is, in our opinion, against the establishment of any general tolerance to the Rh antigens under the natural conditions of human pregnancy.

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Production of Organ-Specific Antibodies following an Induction of Tolerance to Antigens of Heterologous Organs

One of the limiting factors in the study of organ-specific antigens is the existence in tissue cells of antigenic components that are either common to all organs of the same organism, that is, determined by its genetic constitution, or shared with one or a few other organs. These constituents are usually more strongly antigenic than those which are strictly organ-specific[1]. Ordinary immunological methods of producing anti-organ sera by hetero-immunization with organ extracts are therefore not sensitive enough to elicit antibody response against the minor, but strictly organ-specific, antigens. The recent development of methods for producing immunological tolerance[2] seems to open up new possibilities of differentiating between these two types of antigens. It has been shown that the introduction of certain antigens at the fœtal[3] or neonatal[3] stages renders the animals tolerant to these antigens. We have attempted to adapt these methods of producing acquired tolerance to elicit a state of non-responsiveness in rabbits to those antigens which one organ of a mouse shares with another. It was expected that rabbits in which tolerance had been produced to antigens of organ *A*, when later immunized by extracts of organ *B* of the same genotype, would produce antibodies only against *B*-specific antigens, that is, would not respond to the antigens which organ *B* shares with organ *A*.

The organ antigens tested were saline extracts of heart and brain of *C3H* mice. Three control rabbits were immunized by intravenous injections of brain extracts of *C3H* mice (seven injections, 3 mgm. protein each). The antisera were tested for precipitins by the interfacial ring test. All three control rabbits were found to react almost to the same extent against heart and brain, giving a titre of 125. Attempting to eliminate the antibody response against antigens which brain shares with heart, a group of five rabbits was injected immediately after birth, then every two days for two months, with heart extract (1·5 mgm. protein per injection). Thirty days after the last inoculation of heart extract, no precipitins were found in these rabbits against heart

or against brain. The animals were then immunized against brain, as in the controls, and the antisera were then tested against both organs. The results confirmed the expected increase of specific anti-brain response. Three rabbits reacted only with brain (titre 125), and showed no cross-reaction with heart extract. One rabbit reacted similarly with brain, but showed also traces of reaction against the heterologous organ (titre 1). One rabbit did not differ from the controls, reacting to the same antigen dilution with both heart and brain.

A similar but reversed set of experiments was carried out, aiming at increasing the specific reaction against heart antigens. Brain extracts were injected into newborn rabbits, starting with 2 mgm. protein per injection, and increasing gradually to 4 mgm., in a schedule similar to that used in the previous experiment. When these rabbits were then immunized with heart extracts, antisera were obtained which reacted specifically with the homologous organ, while with brain extracts, only traces of precipitins were found. Control anti-sera produced by injections of heart extracts into rabbits which had not been pretreated with brain reacted to the same dilution with both organs.

It seems, therefore, that the introduction into neonatal rabbits of heart or brain antigens inhibits the later development of the capacity to produce cross-reacting antibodies. This specific inhibition is apparently related to the phenomenon of actively acquired tolerance, and it may serve as a tool for eliciting specific antibody response against selected types of antigenic components within the complexes of numerous organ antigens.

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Demonstration of Cortisol in Fish Blood

Previous investigators[1] have shown the presence of glycogenic activity, presumably of adrenal steroidal origin, in the plasma of the salmon (*Salmo salar*). An appreciable part of the activity could be accounted for by steroids reacting as 17-hydroxycorticoids by the Nelson–Samuels analytical method[2]. Since this technique measures a variety of materials having a dihydroxyacetone side-chain on the 17 carbon, the specificity of the determination is questionable in species of which the pattern of adrenal steroid secretion has not been established. Moreover, although cortisol (which is measured by the Nelson–Samuels method) is the chief steroid in the plasma of some mammals, in others the chief steroid, corticosterone, is not detectable by this method. This is especially important because Hatey found the concentration of glycogen-depositing activity to be much higher than could be accounted for by the 17-hydroxycorticosteroids[1]. The nature of the steroid responsible for a large part of the biological activity of salmon plasma remains uncertain. An attempt has therefore been made to determine the nature of the circulating steroids in fish blood by application of paper chromatography.

Heparinized blood was obtained by severing the tail of several Connecticut River carp (*Cyprinus carpio*) caught in October after the spawning season. After the sex of the fish had been determined, blood from male and female fish was pooled separately and the plasma separated. (Although attempts were made to prevent blood clotting with heparin, some coagulation did occur. 'Plasma' therefore actually refers to a mixture of plasma and serum.) Appropriate amounts of plasma were extracted with redistilled chloroform, and the extract applied to a line across the centre of a sheet of methanol-washed Whatman No. 1 paper. Standard spots of cortisol, corticosterone and progesterone were also applied. The sheet was then equilibrated in petroleum-ether/methanol/water (50 : 37·5 : 12·5) and a chromatogram developed for two hours. At the end of this time the paper was removed from the tank and dried. The chromatogram was cut off about 5 cm. in the direction of the solvent front from the origin and examined by ultra-violet light and alkaline fluorescence[3] for the presence of Δ^4,3-ketosteroids. In this system corticosteroids do not move from the origin, but progesterone is easily distinguished.

The remainder of the paper, containing the origin, was placed in another chromatography tank with the steroid spots upward, and, after equilibration, was run for four hours in toluene/methanol/water (50 : 35 : 15). After development of the chromatogram, it was dried and sprayed with blue tetrazolium. The strip was examined for the presence of substances which absorb ultra-violet light, reduce blue tetrazolium and fluoresce with a characteristic colour in alkali. Cortisol and corticosterone can be separated in this system.

No progesterone or corticosterone was found in either male or female carp plasma. A considerable amount of a substance with the mobility of cortisol was detected. The quantity of cortisol-like material present was determined by the method of quantitative paper chromatography[4] using cortisol-4-^{14}C as a tracer and applying a correction based on isotope dilution for losses during chemical manipulations. The pooled specimens of carp plasma were found to contain 43·8 μgm./100 ml. of cortisol-like material in the female and 24·4 μgm./100 ml. in the male.

The identification of the steroid of carp plasma as cortisol is not quite definite; however, the following results support this interpretation: the steroid has the same mobility as cortisol in the toluene/methanol/water system, which is sufficiently sensitive to separate cortisone from cortisol without difficulty. Since it fluoresces in alkali, it contains a Δ^4,3-ketone[3]; since it reduces blue tetrazolium, it has an α-ketol, presumably a 21-ol, 20-one. On mixed chromatogram the mobility of the steroid from fish plasma was indistinguishable from that of authentic cortisol-4-^{14}C.

Attempts were made to demonstrate steroids in the plasma of the black-backed flounder (*Pseudopleuronectes americanus*). Unfortunately, the quantities of plasma available were smaller than in the case of the carp. In pooled plasma from 25 male and female flounders, some immature and some approaching spawning, approximately 16 μgm./100 ml. were found; however, since no radioactive

correction was applied for losses in processing, this figure is a minimum value.

Thus a steroid, presumably cortisol, has been demonstrated in the plasma of a fresh-water fish (*Cyprinus carpio*) and a salt-water fish (*Pseudopleuronectes americanus*).

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Adaptive Formation of Nitrate Reductase in Rice Seedlings

IN the course of studies on rice respiration[1] we observed certain phenomena which point to the possibility of adaptive enzyme formation in higher plants. In order to establish conclusively the ability of a higher plant (rice seedling) to form adaptive enzymes, the present experiments were performed on the adaptive formation of nitrate reductase in rice seedlings.

Tolbert and Burris (see ref. 2) first observed adaptive formation of glycolic dehydrogenase in higher plants, but Kolesnikov and Emenova[2] failed to confirm their findings. McElroy and Nason[4] made a general statement about adaptive formation of nitrate reductase in their review, but in the original account of Evans and Nason (see ref. 4), the results are conclusive only for *Neurospora* and not for bean seedlings. The recent note of App and Meiss[5] suggests adaptive formation of alcohol dehydrogenase in rice, and Cheniae and Evans (see ref. 5) do not consider nitrate reductase in root nodules as an adaptive enzyme. Rice, at its seedling stage, does not reduce nitrate[6] without special treatment; in older rice plants nitrate reductase was first reported by Mitsui[7].

Four- to six-day old rice seedlings (var. Yinfang) similar to those used in the respiration experiments[1] were employed. Seeds were disinfected with 5 per cent formalin solution for 30 min., washed and placed in large Petri dishes to germinate on filter paper. The basic media used for germination were Sörensen phosphate buffer (*M*/15) at the desired *p*H values. For the control experiments, seeds were left to germinate and grow in the buffer alone. For the experimental lots, equimolecular mixtures of potassium and sodium nitrate at different concentrations were added to the buffers for the induction of nitrate reductase formation in the seedlings. In another control experiment, the nitrate was replaced by ammonium sulphate as the nitrogen source in the buffer solution. The *p*H of the solutions ranged from 4·5 to 8, and the total nitrate concentrations from 1 m*M* to 96 m*M*. The Petri dishes with the seeds were kept in the dark, at 30° C. At the end of four to six days, when the seedlings were taken out for enzyme assay, the plants had already attained a length of about 5 cm. Equal portions (by weight) of the seedlings were washed with sterile water and triturated in iced porcelain mortars. The triturated tissues were placed in test-tubes with 2 ml. *M*/15 phosphate buffer, *p*H 7, 1 ml. of *M*/10 potassium nitrate, and covered with a layer of toluene. As a further precaution, 2,000 units of penicillin and 10γ of streptomycin were added to some reaction mixtures. The reaction tubes were incubated at 30° C. for 1–2 hr., after which they were tested for the presence of nitrite by the colorimetric method of Snell and Snell; this is the customary method for the assay of nitrate reductase, and was used by one of us (Wu) in previous work on this enzyme[8].

For each series of experiments the following tests were carried out: (1) control; ground tissues of seedlings grown in buffer alone; (2) ammonia control; that is, ground tissues of plants grown in buffer solutions with ammonium salts as nitrogen source; (3) 'adapted' plants; that is, ground tissues of seedlings grown in buffer solutions containing nitrates; (4) boiled tissues; the same as (3), but the tissues boiled for 15 min. in a water-bath to inactivate the enzyme; and (5) blank; only the analytical reagents as used in (3). All reaction tubes contained the ground tissue, 2 ml. of buffer, 1 ml. of *M*/10 potassium nitrate, and 0·2 ml. toluene, and were incubated for 2 hr. at 30° C. The weight of tissue in each tube was approximately the same (about 0·4 gm. fresh weight).

In a typical experiment, 'adapted' rice seedlings, germinated for five days at *p*H 5 in 6 m*M* nitrate ion, gave 0·028 micromole nitrite ion per gm. fresh weight of tissue per hr. All other treatments gave negative results.

The fact that nitrate reductase activity is absent in tissues from seedlings grown in buffer alone (test 1) shows that this enzyme is not present in unadapted rice seedlings. It occurred only in seedlings which had been kept for five days with nitrate ion (test 3). That the reduction of nitrate to nitrite by this reaction mixture (test 3) is due to enzyme activity was shown by the loss of activity of the same preparation after boiling (test 4). The fact that the enzyme is absent in ammonia-grown plants argues against the general role of nitrate as a mere source of nitrogen for enzyme activity. However, Morton[9] pointed out the interference of ammonia in the activity of this enzyme. Tests (1) and (2) also rule out the possibility of any nitrite which might originally be present in the seedlings. The possibility of nitrite being present in the reagents employed in the test was ruled out by the blank (test 5). Repeated tests and rigid precautions ruled out the possibility of any microbial interference during tests for the enzyme.

Hence we believe we have demonstrated the adaptive formation of nitrate reductase in rice seedlings (var. Yin-fang), which is a clear instance of the formation of an adaptive enzyme in higher plants induced by substrate.

Quantitative experiments show that with five-day old rice seedlings in (*M*/15) phosphate buffer, the best condition for the adaptive formation of nitrate

reductase in these seedlings is 6–12 m*M* nitrate at *p*H 5. The maximum activity in five-day seedlings may reach 0·196 μ*M* nitrite formed per gm. fresh weight per hr. with incubation at 30°. Experiments with seedlings grown in quartz sand and in the light fully confirm these findings and they gave even better results. Details of these experiments will be published elsewhere.

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The Northern Octocoral, *Paragorgia arborea* (L.), in Sub-antarctic Waters

Some very interesting information has come to light during examination of the *Discovery* collections of octocorals concerning the supposed amphi-boreal alcyonarian *Paragorgia arborea* (L.). This species was considered an Atlantic boreal species (see Broch[1]) until Kinoshita[2] and Hickson[3] almost at the same time reported its presence on both sides of the northernmost Pacific. In the same period, Nutting[4] identified a *Paragorgia nodosa* Kor. and Dan. from Hawaiian waters in 423–438 fathoms, where the bottom temperature was 41·0° F. (+ 5° C.). A re-examination of Nutting's specimen by me has revealed that this species is identical with *P. arborea*. When discussing the zoogeographical features of this species[5], I characterized it as strictly boreal, but the record by Madsen[6] of a specimen off the Portuguese coast (without biological and hydrographic data) raised doubts about this interpretation of its zoogeography.

It is therefore of very great interest that R.R.S. *William Scoresby* took *Paragorgia arborea* at some stations in sub-antarctic waters. The localities are given below:

Station WS 98. 49° 54′ 15″ S., 60° 35′ 30″ W., April 18, 1927, 173–171 m. (temperature 5·3° C. at 165 m.).
Station WS 99. 49° 42′ 00″ S., 59° 14′ 30″ W., April 19, 1927, 251–225 m. (temperature 5·94° C. at 220 m.).
Station WS 231. 50° 10′ 00″ S., 58° 42′ 00″ W., July 4, 1928, 167–159 m. (temperature 5·81° C. at 160 m.).
Station WS. 772. 45° 13′ 00″ S., 60° 00′ 00″ W., October 30, 1931, 309–163 m. (temperature 4·59° C. at 300 m.).
Station WS 783. 50° 03·5′ S., 60° 08′ W., December 5, 1931, 165–157 m. (temperature 4·89° C. at 155 m.).

The first three stations are just north of the Falkland Isles, and the last two are on the Patagonian Shelf, the northernmost (Station 772) being north-east of Cape Tres Puntas. All these stations have bottom temperatures as in the typical central boreal bottom area, and we may say that they stamp the Patagonian Shelf including the Falkland Isles as parts of a true anti-boreal bottom area. Here *Paragorgia arborea* lives in temperatures between + 4·5° and + 6° C., the depths of the localities ranging from 157 to 309 m. in agreement with the shallower part of its habitat in the north-eastern Atlantic. This may, however, merely reflect the difficulties of obtaining material from deep rugged bottoms where scientific trawling is almost impossible.

The southern records of *Paragorgia arborea* are of especial interest in a discussion concerning bipolarity. The species must be looked upon as a 'bipolar' species so long as we have no intermediate records in low latitudes between those and the boreal localities (see Broch[8]). In this connexion, however, I wish to mention Powell's report[7] on *Discovery* Mollusca, and especially his map of the distribution of *Fusitriton* and *Aforica* (on p. 65). It seems to give a reasonable explanation of the dispersal and recent distribution in the Pacific, including the Hawaiian locality. On the other hand, on our present knowledge a continuous distribution from north to south in the Atlantic Ocean between the Patagonian (anti-boreal) Shelf area and the Atlantic boreal habitat seems unlikely. It is possible that its penetration into the North Atlantic was achieved by circumpolar dispersal through the Bering Straits as suggested in an earlier paper[5].

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A New Growth-promoting Factor for *Mycobacterium tuberculosis*

Though *Mycobacterium tuberculosis* can be grown as a uniform suspension in the liquid medium of Dubos and Davis[1], for biochemical purposes where large masses of bacteria are required, the organism is, even at present[2], grown as surface pellicles on Youmans's media[3]. The cells are harvested from this medium at the end of 2–3 weeks.

In our attempt to shorten the period of incubation of *Mycobacterium tuberculosis* (*H37R*$_v$) grown as surface culture, we found that the water of tender coconuts ('coconut water') could considerably reduce the number of days required for full growth. The addition of the coconut water, even in a dilution of 1 in 10,000, to the Youmans's medium facilitated earlier growth, and the maximum growth normally attained on the Youmans's medium by about the twentieth day was found to have been reached in this modified medium by the twelfth day alone. There was no growth on coconut water by itself. The growth-promoting factor was found to be heat-stable.

Systematic fractionation was undertaken to isolate this factor. The coconut water was devoid of polypeptides or proteins, as indicated by ammonium sulphate fractionation. The ether extract of coconut water was evaporated to dryness, dissolved in a small quantity of ethylene glycol and made up to the original volume. To the water layer was added ethyl alcohol to 75 per cent concentration and the precipitated polysaccharides centrifuged off and suspended in the original volume of water. The supernatant was shaken with three times its volume

Table 1. Effect of Coconut Water and its Fractions on the Growth of *Mycobacterium tuberculosis* in Youmans's Medium

	Fractions		Growth on fourth day
1.	Control (Youmans's medium)		Sl.
2.	Coconut water + Youmans's 1/100		+
3.	Ether-soluble fraction	,,	Sl.
4.	Polysaccharide fraction	,,	++
5.	Amino-acid fraction	,,	Sl.
6.	Residue + Youmans's	,,	Sl.
7.	Coconut water alone	,,	0

Sl. = slight growth.
+ = growth covering the entire surface.
++ = growth covering the entire surface and extending up the sides of the tube.

of chloroform and the water layer passed through 'Dowex-50' resin (200–250 mesh) which had been regenerated in the hydrogen cycle. The eluate containing free sugars was not treated further. The amino-acids from the resin were eluted with 0·15 *N* sodium hydroxide, desalted[4] and made up to the original volume. Of the four fractions, namely, lipids, polysaccharide, amino-acids and the residue, only the polysaccharide fraction showed a growth-promoting effect as a supplement to Youmans's medium. The overall effect of the coconut water and its components is indicated in Table 1.

The active fraction gave a positive Molisch test but no biuret test. It gave no colour with iodine and the test for pectin was negative. The end sugar was not a ketose (negative Seliwanoff reaction) and, on acid hydrolysis, glucose and fructose were detected[5].

The effect of this rapid growth, induced by the polysaccharides fraction, on the virulence of the organism was studied in experimental tuberculosis of mice. As judged by the extent of lesions produced and survival time, no variation in the virulence of the Mycobacteria, as compared to those grown on Youmans's medium, was observed.

It is of interest to make a short comparison between this growth-promoting factor for *M. tuberculosis* with the plant growth factors isolated from coconut water by Steward and his co-workers[6]. While the latter did not promote the growth of carrot roots to the same extent as the original water itself, the polysaccharide fraction stimulated the growth even better than the coconut water. Steward *et al.* found that the addition of casein hydrolysate improved the activity of the growth-promoting factor for plant tissues, whereas in the case of the polysaccharide fraction, the addition of casein hydrolysate did not further increase its growth-promoting activity for *M. tuberculosis*.

Further work on the purification and characterization of the polysaccharide growth factor is in progress. We thank Prof. K. V. Giri and Dr. K. P. Menon for their interest in the work and Mr. V. Srinivasan for his technical assistance.

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Systemic Effect of Dieldrin on the 'Body Louse' of Poultry

P. J. McCosker has suggested[1] that the Mallophaga *Eomenacanthus stramineus* does not take the blood of its host. However, Crutchfield and Hixson[2] found that this species normally feeds on blood in addition to feathers. It is probable that this diet is common to many species belonging to the superfamily Amblycera; also some species seem to feed on the host's fluids only. It would be interesting if these experiments could be repeated using one of the chicken lice belonging to the genera *Goniodes*, *Goniocotes*, *Lipeurus* or *Cuclotogaster* of the superfamily Ischnocera, which are believed to feed on feather parts only.

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I was glad to have my attention directed to the paper by Crutchfield and Hixson[1] indicating that *Eomenacanthus stramineus* does normally feed on blood in addition to feathers. The authority for my statement was Roberts[2], who states: "This louse is considered to feed on scales and skin secretions, but since blood can be found in its alimentary canal it has been suggested that this may not be entirely accidental".

With regard to other species of poultry lice, my information at the moment is limited to observations made while examining the hourly pattern of drop-off of the body louse. In this experiment, it was noticed that not only *Eomenacanthus stramineus* but also *Goniocotes gallinae* and *Lipeurus caponis* fell from treated birds in larger numbers than from control birds. All three species seemed to have the same pattern of mortality. From this, the general conclusion can be drawn that dieldrin had some systemic effect on these parasites. However, as no attempt was made to grade the infestation of these lice either before or after treatment, no conclusion can be drawn as to how effective the treatment was.

Further experiments are being designed to get more detailed information on the systemic effect of dieldrin and aldrin on natural infestations of these two parasites and also the head louse, *Menopon gallinae*.

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Experimental Transmission of *Loa loa* from Man to Monkey

The purpose of this preliminary communication is to record the successful experimental transmission of *Loa loa* from man to monkeys (*Mandrillus leucophaeus*). The results will be published in full elsewhere.

Three young *M. leucophaeus* were captured in the rain-forest near Kumba, British Cameroons. After

Table 1. Results of infecting three young *M. leucophaeus* with infective forms of *L. loa* derived from 'wild' *C. silacea* fed on a heavily infected human volunteer

Monkey	Total No. of infective forms of *L. loa* inoculated	No. of flies from which infective forms were obtained	Length of incubation period, that is, to appearance of microfilariæ in peripheral blood	Periodicity of microfilariæ	No. of adult *Loa* worms found at autopsy
Alice	320	5	5 months	Diurnal	106
Mamfe	250	4	6 "	"	113
Elliott	600	5	6 "	"	Monkey still alive

capture they were kept in screened cages for a period of six months quarantine, during which time repeated day and night blood films showed no microfilariæ. At the end of the quarantine period 'wild' *Chrysops silacea* were fed upon a human volunteer whose blood contained more than 1,000 microfilariæ of *L. loa* per 50 c.mm. After taking their infected blood-meal, the flies were kept alive in the laboratory, fed only on sugar water, and 9–10 days later those which survived were dissected in sterile saline and the infective forms of *L. loa* which had developed in them were inoculated subcutaneously by syringe into the monkeys. Between five and six months after inoculation, diurnally periodic *Loa* microfilariæ appeared in the peripheral blood of all three monkeys, and in two, which were later autopsied, adult *Loa* worms were found, of small somatic size (males 1·7–3·2 cm. long and 270–330μ in diameter; females 3·1–5·5 cm. long and 360–460μ in diameter) and closely resembling *L. loa* from man.

The results are set out in Table 1.

Although *L. loa* from man has thus been shown to be experimentally transmissible from man to *M. leucophaeus*, there is good evidence that under natural conditions in the rain-forest zone of the British Cameroons such transference takes place extremely rarely. The form of *Loa* which is commonly found in naturally infected *M. leucophaeus* and in other monkey species (*Cercopithecus nictitans martini* and *C. mona mona*) can be distinguished from the human parasite, when the latter is fully developed in *M. leucophaeus*, by its large adult somatic size (males 2·0–4·5 cm. long and 350–400μ in diameter; females 4·6–11·0 cm. long and 560–750μ in diameter) and by the nocturnal periodicity of its microfilariæ.

By inoculating into *M. leucophaeus* the infective forms of *Loa* carried by 'wild' naturally infected *Chrysops*, and by observing afterwards the microfilarial periodicity of the infection which develops, it has been possible to determine which species of *Chrysops* are the natural vectors of the human and simian parasites. The results indicate that the monkey parasite is transmitted among the simian population by the crepuscular forest canopy-dwelling *C. langi* and *C. centurionis*, species which, under natural conditions, never bite man. The human parasite, on the other hand, is transmitted from man to man by *C. silacea* and *C. dimidiata*, species the habits of which bring them into close association with man.

There is no evidence that the nocturnally periodic simian parasite is ever transmitted successfully to man under natural conditions, and only very rarely is the diurnally periodic human parasite naturally transmitted to monkeys, presumably by *C. silacea* or *C. dimidiata*.

In the Cameroons rain-forest the human and monkey parasites appear to be evolving in different host–parasite–vector complexes, with very little interchange between them, and the monkey population can be regarded as an academic, but not an effective, reservoir for the human parasite *L. loa*.

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Rhizoctonia Damping-off of some Vegetables in Iraq

The only reference to damping-off disease of vegetables in Iraq that we have seen is that of Al-Adhami[1], who reports that damping-off of cabbage, cauliflower and tomato is caused by *Pythium de baryanum*.

In this investigation, isolations from damped-off seeds and seedlings of five vegetables, namely, cabbage, cauliflower, cucumber, vetch and peas, according to the methods described by Tolba[2], revealed the presence of the following fungi: *Rhizoctonia solani*, *Pythium intermedium*, *Fusarium* sp., *Sporotrichum* sp., *Penicillium* spp., *Aspergillus* spp., *Mucor* spp. and *Hormodendrum* sp.

Pathogenicity tests of the various fungi isolated were carried out by sowing seeds of the above-mentioned plants in soils containing each of the test fungi after adjusting their moisture content to 40 or 60 per cent water-holding capacity. Controls were kept in sterile soil at the same moisture-level. The containers were incubated at two temperature-levels, namely, 5°–25° C. and 9°–37° C., for a period of four weeks, during which emergence, post-emergence damping-off and survival counts were made.

The methods used for soil inoculation, determination of the water-holding capacity of the soils and standardization of the soil water content were those referred to in a previous paper[2].

The results of this experiment revealed that *Sporotrichum* sp., *Penicillium* spp., *Aspergillus* spp., *Mucor* spp. and *Hormodendrum* sp. were completely non-pathogenic and may be considered as secondary parasites or saprophytes and for the purpose of this communication call for no further mention.

The results also showed that all seeds of the five vegetables failed completely to emerge from soils inoculated with *Rhizoctonia solani* at the two temperature-levels and soil-moisture contents used. On the other hand, *Pythium intermedium* and *Fusarium* sp. proved to be very weak pathogens with regard to damping-off of the five test vegetables.

In another set of experiments, seedlings of the five vegetables were raised in sterile soil at a medium moisture content. Four days after the seedlings appeared above soil-level, 15–20 seedlings of each vegetable were inoculated with *R. solani*, *P. intermedium* or *Fusarium* sp. Inoculation was carried out by inserting disks from 2-day old agar cultures of *R. solani* or from 7-day old cultures of *P. intermedium* or *Fusarium* sp. on their hypocotyls just above soil surface. Controls inoculated with disks of agar free

Table 1. Percentage Post-Emergence Damping-off of Seedlings of Five Vegetables inoculated at Soil-Level with Agar Disks containing *R. solani*, *P. intermedium* or *Fusarium* sp. (Medium Soil Moisture-Content; Temperature 0–30° C.)

Vegetable	Percentage post-emergence damping-off induced by		
	R. solani	*P. intermedium*	*Fusarium* sp.
Peas	100	0	9
Cucumber	100	0	0
Cabbage	87	14	8
Cauliflower	100	20	12
Vetch	100	0	12

from the fungus were kept. All seedlings were kept in the greenhouse where the temperature ranged between 0° and 30° C. The seedlings were observed for a period of four weeks and the number of damped-off seedlings was recorded. The results of this experiment are set out in Table 1. Seedlings inoculated with disks of agar free from fungi remained healthy throughout the experimental period and hence their results are omitted from Table 1.

Table 1 shows that *P. intermedium* and *Fusarium* sp. are weak pathogens so far as the post-emergence phase of damping-off disease of the five test vegetables is concerned. On the other hand, *R. solani* proved to be a destructive damping-off causal organism.

From the results of this and the previous experiment it can be safely concluded that, contrary to the findings of Al-Adhami[1], *R. solani* is the main causal organism of both pre- and post-emergence phases of damping-off disease of cabbage and cauliflowers as well as the other three vegetables tested. It may be worth mentioning in this respect that *Pythium de baryanum*, which was reported by Al-Adhami[1] as the causal organism of damping-off of cabbage and cauliflower, was never met with on the isolation plates throughout this investigation.

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Development of Female *Schistosoma spindale* in the Guinea Pig

Previous workers[1] have reported that only the male of *Schistosoma spindale* develops in the guinea pig. Fairley, Mackie and Jesudasan, who carried out a detailed investigation, suggested that "some peculiar host reaction to the less robust female schistosome probably underlies this phenomenon in the case of *S. spindale*". A comprehensive study was undertaken of this apparent immunity to only one sex of a metazoan parasite, as a result of which it has been found that female *S. spindale* also develops in the guinea pig.

Twenty-four guinea pigs of both sexes and one and a half months to two years of age were exposed to cercariæ of *S. spindale* discharged by naturally infected *Indoplanorbis exustus*. The snails were collected during August, September and October 1954 from a local tank frequented by infected buffaloes. Each animal was exposed to the cercariæ percutaneously by keeping three-fourths of its body immersed in water containing the larvæ. Two-litre glass jars were used for the purpose. The duration of exposure was about three hours. The number of cercariæ employed per guinea pig varied from 8,000 to 50,000, and that of the snails furnishing the cercariæ from 22 to 77.

One guinea pig died early and another could not be examined for other reasons. Of the remaining twenty-two animals, which either died or were autopsied 33–153 days after exposure, seventeen provided conclusive evidence of the development of female *S. spindale* and two furnished inconclusive evidence. The male *S. spindale*, however, developed in all the twenty-two animals. Among the seventeen conclusive cases of infection with female *S. spindale*, mature females and pseudotubercles containing the characteristic ova in liver, intestine or lung were obtained in eight, immature females in four and only pseudotubercles containing the ova in the remaining five. The two inconclusive cases contained the pseudotubercles, but the ova inside were degenerate and not very distinct. The maximum number of immature females recovered was 440, while that of mature females was eleven. The live immature females were filamentous and the edges of the body tended to infold ventrally, forming a 'pseudogynæcophoric canal'. The ventral sucker was comparatively more developed. The females were shorter than the males. The maximum number of uterine ova was three. The earliest period in which the females attained maturity, as evidenced by the appearance of ova in the uterus and host tissue, was 48 days; but in a few cases they had remained immature up to 99 days after exposure. Ova were never detected in the fæces of the infected animals.

The present study thus shows that the female of *Schistosoma spindale* may also develop in the guinea pig, which therefore does not possess total immunity to the female schistosome. But this species of animal is not a very suitable host of the female schistosome, as is evidenced by the facts that in a few cases the females did not develop at all; in others they remained immature up to more than three months and in still others they were apparently destroyed after the production of ova. This variability in the susceptibility of guinea pigs to the infection may be explained on the basis of individual immunity of varying degree. The difference between the present observations and those of the previous workers may mostly be attributable to the variability in the susceptibility of the host. It is, however, possible that the infection reported by Fairley *et al.* was not purely unisexual, for the immature filamentous worms recorded by them were, perhaps, only the immature females of *S. spindale*. As mentioned above, similar worms were found in the present investigation also.

A detailed account of this work will be published elsewhere. I am grateful to Mr. L. Sahai, director of this Institute, for his interest in the work, and to Dr. H. D. Srivastava, head of the Division of Parasitology, for providing the requisite facilities.

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A New Technique for the Viable Count of Bacteria

The general principle followed so far for the viable count of bacteria in a suspension is either to count the number of colonies produced by a very dilute suspension of bacteria on an agar plate[1] or to observe the differential staining behaviour of the living bacterium to distinguish it from the dead one[2]. No reliable technique has yet been recorded for identifying viable cells in a mixed suspension of viable and non-viable bacteria when counting under the microscope. I have been able to identify living bacteria during the counting process by the hæmatocytometer method.

In this technique, bacteria were grown in the nutrient broth, to 100 c.c. of which 1 gm. of 2, 3, 5-triphenyltetrazolium hydrochloride was added. Bacteria were inoculated on nutrient agar slants and after incubation for 18 hr. they were washed with 5 c.c. sterile nutrient broth. The number of bacteria per cubic centimetre in this slant-washed suspension was counted. The nutrient broth with the tetrazolium salt was inoculated with 1 c.c. of that suspension and incubated at 37° C. After incubation for 1 hr., the number of bacteria in the broth was counted with the conventional hæmatocytometer, using 4 per cent formalin as diluting fluid. Formalin kills the bacteria and at the same time fixes them. Moreover, formalin does not impair the effect of tetrazolium salt in staining the bacteria. The killed and fixed bacteria were counted with the ordinary light microscope having objective with 0·65 N.A. and 12× eyepiece. The living bacteria were observed to have a reddish tinge whereas the dead cells were completely transparent. The fact that the stained cells were alive was proved by their ability, before treatment with formalin, to produce a colony when inoculated, whereas the unstained bacteria did not develop any colonies. The simple growth curve of the viable and total count of *E. coli* (*G* strain) in nutrient broth by this method up to 12 hr. of growth is shown in Fig. 1.

In this technique, tetrazolium salt was used on the assumption that the mitochondria of living bacteria would reduce the salt in red formazan bodies[3], whereas in the dead bacteria, enzymatic activities of the mitochondria would be impaired and consequently formation of the red formazan particles would not occur. Under the microscope, the reddish stain which the viable cells exhibited was, in fact, due to these red formazan bodies. Moreover, tetrazolium salt did not produce any toxic effect to the bacteria so the rate of growth of the culture was not retarded. This was proved by a control experiment using the nutrient broth without adding tetrazolium salt to it.

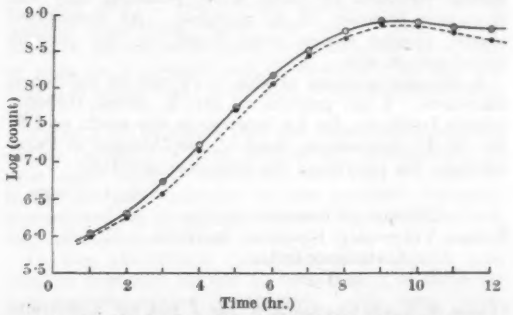

Fig. 1. Growth of *Escherichia coli* (*G* strain) in broth. Continuous line represents total count and interrupted line the count of viable bacteria

Thus it is possible to use the tetrazolium salt for counting the viable cells along with the total count of bacteria in a suspension.

I thank Prof. N. N. Das Gupta for his interest in the work; and I am indebted to Mr. K. N. Bhattacharya for helping in some preparatory aspects of the work.

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A Simple Spore Trap

When studying an air-borne plant pathogenic fungus, it is often desirable to determine whether the spores of the organism are present in the atmosphere at particular times. When accurate data suitable for statistical analysis are required, the use of apparatus such as the Hirst[1] spore trap is desirable. However, lack of funds or the absence of need for elaborate data may preclude such a purchase. The alternative would seem to consist of placing suitably treated microscope slides in a fixed position—a method known to be relatively inefficient. In seeking a compromise, the following spore trap was designed.

Three main considerations were involved in the construction of a suitable apparatus. First, it was desirable that a volume of air larger than normal be permitted to pass over the surface of microscope slides. Secondly, it was necessary to ensure that at all times the slides would face into the wind; and thirdly, the air must pass over the surface of the slides free from turbulence, thus facilitating the deposition of the spores on suitably treated slides. The design finally adopted was evolved by experimentation and consideration of aeronautical problems.

The apparatus was constructed in aluminium and consisted of a convergent cone, which faced into the wind, leading into a divergent cone of similar size. The leading edge of the convergent cone had an internal diameter of 7½ in., narrowing down to a diameter of 3¾ in. over a 12-in. length. At this point the diameter remained constant for a length of 2 in. and gave a smooth slide fit into the rear half collar of the divergent cone.

A slotted holder for two 3 in. × 1 in. microscope slides was mounted in the central 2-in. area in such a way that the slides were held in a constant position, tilted at an angle of 30° to the horizontal.

Two wind vanes were mounted vertically in a central position on the top and bottom of the rear divergent cone and their weight was counter-balanced by addition of a reinforcing ring on the front cone.

The cones were mounted on a relatively short pivot spindle which ended in a 60° angle point. The last 6 in. of the spindle fitted inside a pipe of slightly larger diameter with the point resting in the centre of a 90° angle seat so that there was a 30° angle difference between the angle of the cone-shaped point of the spindle and its seat. The space between the spindle and the slightly wider-bore pipe was filled with oil to allow the spindle to rotate freely. With this design it was found that the cones were extremely sensitive to even the slightest changes of wind of very low velocity.

The spore trap was set up at a height of 6 ft. above ground-level. A thin film of paraffin and rubber lubricant spread over the slide surface was found to be a satisfactory sticker. The treated slides were easily placed in position, were protected from rain, and could be changed as frequently as desired.

Such a spore trap has been in operation for more than a year and has given very satisfactory results.

I am indebted to Flight Lieut. H. Pringle, of the Royal Rhodesian Air Force, for his practical assistance and advice in connexion with the development of the spore trap.

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Appraisement of Total Activity in Laboratory Animals

THE effect of environmental conditions on the activity of small laboratory animals is usually recorded in terms of locomotor activity as indicated by the revolutions of rotating cages. Work in progress with an animal calorimeter[1] indicates that a considerable amount of time and energy is spent in other activities such as washing, scratching and gnawing. The apparatus described below has been constructed to record evidence of all types of activity.

A triangular plywood table has three metal legs ending in flexible feet made from short lengths of rubber tubing. Half-way down its length each tube is encircled by a metal cylinder. The rubber tube stands on the base of a copper vessel the inner vertical surface of which is insulated. This vessel contains carbon granules which provide a resistive path between its base and the metal cylinder. These three carbon resistance units are connected in series with an accumulator and a fixed resistor.

The animal, in a light cage, is placed on the table. As the animal moves the table vibrates, thus changing the resistance of the carbon units. This gives rise to a variation in the current and hence in the potential difference across the fixed resistor. This variation in potential difference is amplified and applied to a pen recorder.

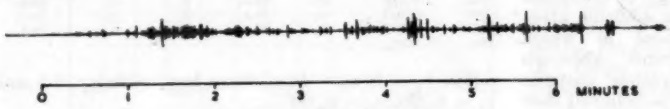

Fig. 1

A typical trace for a single mouse (25 gm.) in a standard cage (600 gm.) is shown in Fig. 1. The trace was recorded on an 'Ediswan' oscillograph (type *EPR*). The sensitivity to movement can be varied by altering the length of rubber tubing as well as by adjusting the amplifier gain. This enables background vibrations to be eliminated. As the vibrations of the table are heavily damped, the trace obtained follows animal movement very closely.

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New Routes to Tetrahalomethanes

TETRAHALOMETHANES, such as carbon tetrachloride, dichlorodifluoromethane, or chlorotrifluoromethane, are prepared commercially in a variety of ways. New routes to such compounds have now been found starting from carbonyl halides such as $COCl_2$, COF_2, COFCl or COFBr.

Reaction of phosgene with phosphorus pentachloride at 350° C. under pressure yields carbon tetrachloride in 60–70 per cent conversion. Carbonyl fluoride similarly gives dichlorodifluoromethane between 100° and 400° C., though in much lower yield:

$$COX_2 + PCl_5 \rightarrow CX_2Cl_2 + POCl_3; \quad X = F \text{ or } Cl$$

Chlorotrifluoromethane, carbonyl chlorofluoride, and, under certain conditions, carbon tetrachloride, are also produced when $X = F$ by the following side-reactions:

$$COF_2 \overset{PCl_5}{\rightleftharpoons} COFCl + COCl_2 \ (+ PF_2Cl_3, \text{ etc.})$$

$$COCl_2 \overset{PCl_5}{\longrightarrow} CCl_4$$

$$CF_2Cl_2 + COF_2 \longrightarrow CF_3Cl + COFCl$$

$$2CF_2Cl_2 \rightleftharpoons CFCl_3 + CF_3Cl$$

Phosphorus trifluoridedichloride, PF_3Cl_2, or phosphorus pentafluoride, can be used instead of phosphorus pentachloride for reaction with phosgene; similarly, carbonyl chlorofluoride can be treated with phosphorus pentachloride.

It is known that phosphorus oxychloride can be reconverted to phosphorus pentachloride by reaction with carbon monoxide or phosgene in presence of carbon:

$$POCl_3 + CO \text{ (or } COCl_2) \overset{C}{\rightarrow} PCl_3 \text{ (or } PCl_5) + CO_2$$

Reaction of carbon monoxide, chlorine and phosphorus trichloride is thus the basis of this synthesis of carbon tetrachloride which involves the conversion of acyl carbonyl into CCl_2.

Fluorochloromethanes have also been obtained by pyrolysis or copyrolysis of carbonyl halides in flow systems or in an autoclave, for example,

$$COF_2 + COCl_2 \rightarrow CF_2Cl_2 + CO_2$$

$$2COFCl \rightarrow CF_2Cl_2 + CO_2$$

Temperatures between 250° and 700° C. are used, and the conversions are greatest under superatmospheric pressure. Carbonyl chlorofluoride, trichlorofluoromethane, chlorotrifluoromethane, carbon tetrafluoride and carbon tetrachloride are by-products in amounts depending upon the temperature and pressure used:

$$COF_2 + COCl_2 \rightleftharpoons 2COFCl$$

$$COF_2 + COFCl \rightarrow CF_3Cl + CO_2$$

$$COFCl + COCl_2 \rightarrow CFCl_3 + CO_2$$

$$2COF_2 \rightarrow CF_4 + CO_2$$

Reaction of phosgene, or of carbon monoxide and chlorine, with hydrogen fluoride thus provides a new route to the useful compound dichlorodifluoromethane:

$$\begin{array}{ccccccc} & & & & COF_2 + COCl_2 & \rightarrow & CF_2Cl_2 \\ & & & & \uparrow & & \uparrow \text{ } COCl_2 \\ COCl_2 & \xrightarrow{HF} & COFCl & \xrightarrow{HF} & COF_2 & & \\ & & \downarrow & & & & \\ & & CF_2Cl_2 & & & & \end{array}$$

These disproportionation reactions can be catalysed by impregnated active carbon; conversions to chlorofluoromethanes as high as 85 per cent, with a 40–50 per cent conversion to dichlorodifluoromethane and a 20–25 per cent conversion to chlorotrifluoromethane, have been obtained. Full details of these and related investigations will be published elsewhere.

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Oxidation of Metals: Determination of Activation Energies

The activation energies of oxidation of metals and alloys is of fundamental importance in the consideration of oxidation mechanisms. Hitherto, however, the reported values often show large mutual disagreements for the same metal.

The dependence of oxidation reactions upon temperature may be expressed by the Arrhenius equation:

$$k = A.\exp\left(\frac{-Q}{RT}\right)$$

where k is the rate constant for oxidation at temperature T, A is a constant the dimensions of which depend on units for k, R is the gas constant, and Q is the activation energy. In accordance with this equation the activation energy is determined by measuring the rate constant k at different temperatures and plotting $\ln k$ versus $1/T$. This plot yields a straight line the slope of which gives Q/R.

An accurate determination of activation energies involves a large number of oxidation measurements at different temperatures. In this communication a faster method is proposed for the determination of activation energies. The metals are oxidized under conditions of linearly increasing temperature, and the method gives the activation energy of oxidation from one single oxidation run, and in addition gives the approximate temperature regions in which different rate-laws of oxidation are found. Although the proposal for determining activation energies under such conditions is not new[1], it is believed that the present treatment of the results provides a new approach for a simple, rapid and accurate method for studies of oxidation of metals and alloys.

The oxidation of metals follows different rate-laws depending upon the metal, the nature and/or semiconducting properties of the oxide formed, and the temperature. At high temperatures (generally greater than 200–300° C.) the different rate-laws found are: (1) linear, (2) parabolic and (3) cubic; they can be written:

$$\frac{dx}{dt} = k_1 \text{ (linear)}; \quad x \cdot \frac{dx}{dt} = k_2 \text{ (parabolic)};$$

$$x^2 \cdot \frac{dx}{dt} = k_3 \text{ (cubic)}$$

where x represents the thickness of the oxide scale (or gain in weight per unit area) at time t, and k_1, k_2 and k_3 are the oxidation rate constants for the linear, parabolic and cubic rate-laws, respectively. These rate-laws may be written:

$$x^n \frac{dx}{dt} = k \tag{1}$$

when n is a constant having values of 0, 1 and 2 for the linear, parabolic and cubic rate-laws, respectively.

Introducing the Arrhenius equation, we get:

$$x^n \frac{dx}{dt} = A.\exp\left(-\frac{Q}{RT}\right) \tag{2}$$

Oxidizing under conditions with linear increase of temperature, we have:

$$T = at + b$$

or after differentiation,

$$dT = a\,dt$$

Equation 2 thus becomes

$$x^n \frac{dx}{dT} = B \cdot \exp\left(-\frac{Q}{RT}\right) \tag{3}$$

where B is a constant and equal to A/a.

Taking the logarithm of equation 3, we get:

$$n \cdot \ln x + \ln \frac{dx}{dT} = \ln B - \frac{Q}{RT} \tag{4}$$

Rearranging, equation 4 may be written:

$$(n+1)\ln x + \ln \frac{d\ln x}{dT} = \ln B - \frac{Q}{RT} \tag{5}$$

A plot of $(n+1)\ln x + \ln \frac{d\ln x}{dT}$ versus $\frac{1}{T}$ should yield a straight line the slope of which is Q/R, which permits calculation of the activation energy, Q.

The use of equation 5 necessitates the calculation of $\ln \frac{d\ln x}{dT}$ and for this purpose a table of the following type is used for each oxidation run.

t °C.	$\frac{1}{T} \times 10^4$	$x = \frac{m}{A}$	$\ln x$	$2\,d\ln x$	$\frac{d\ln x}{dT}$	$\ln \frac{d\ln x}{dT}$
750	9,775	a_1	$\ln a_1$			
775	9,542	a_2	$\ln a_2$	b_1	c_1	$\ln c_1$
800	9,320	a_3	$\ln a_3$	b_2	c_2	$\ln c_2$
825	9,107	a_4	$\ln a_4$	b_3	c_3	$\ln c_3$
etc.	etc.					

where $b_1 = \ln a_3 - \ln a_1$, $b_2 = \ln a_4 - \ln a_2$ . . . and $c_1 = b_1/50$, $c_2 = b_2/50$ . . .

In applying this approach to metals oxidizing according to the linear rate-law, it is necessary to plot $\ln x + \ln \frac{d\ln x}{dT}$ versus $\frac{1}{T}$; in the case of a parabolic rate-law $2\ln x + \ln \frac{d\ln x}{dT}$ versus $\frac{1}{T}$; and in the case of a cubic rate-law $3\ln x + \ln \frac{d\ln x}{dT}$ versus $\frac{1}{T}$. This treatment of the data should yield straight lines for the particular rate-laws in the corresponding temperature regions. If the oxidation of a metal follows different rate-laws in different temperature regions, distinct breaks in the curves should occur at the corresponding temperatures. Thus, in addition to the activation energy, this treatment also gives approximate temperature regions in which the different rate-laws are found.

Table 1

Metal	Value of n (rate-law)	Temperature increase	Temperature region	Activation energy
Titanium	$n = 1$ (parab.)	3·86 deg. C./min.	700–900° C.	53 kcal.
Nickel	$n = 1$ (parab.)	2·23 deg. C./min.	700–1,050° C.	41 kcal.
Zirconium	$n = 2$ (cubic)	3·86 deg. C./min.	700–1,050° C.	45 kcal.
Copper	$n = 1$ (parab.)	2·23 deg. C./min.	750–1,000° C.	35 kcal.

The method described has been tested for nickel, zirconium, copper and titanium over the temperature range 400–1,050° C., and the results are shown in Table 1.

The activation energies observed are all in good agreement with previously published values[1] obtained by the conventional method of plotting $\ln k$ versus $1/T$. The value for titanium was checked in this laboratory by the conventional method which gave an activation energy of 52 kcal. in the parabolic rate-law region. Furthermore, the method gave good estimates of the temperature regions in which different rate-laws are observed. In the case of oxidation of titanium[2], which follows a cubic rate-law in the temperature region 400–600° C., a parabolic rate-law between 600° and 900° C., and a linear rate-law above approximately 900° C., the method gave results which were in agreement with conventional studies. Results for the oxidation of nickel are shown in Fig. 1.

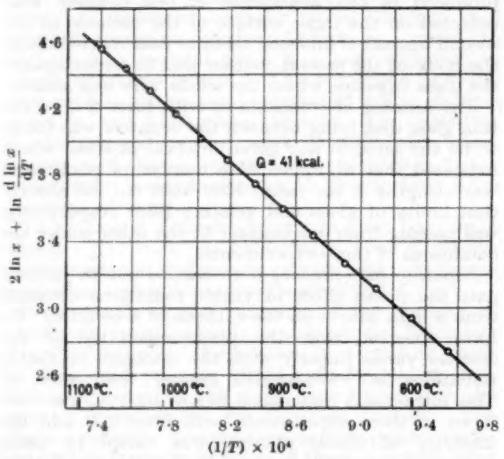

Fig. 1. Determination of the activation of oxidation of nickel by oxidizing under conditions of linearly increasing temperature

A detailed account of the method and the results for a number of metals and alloys will be published elsewhere.

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Preparation of Maghæmite by Electrolysis

WHEN nitrate solutions are employed as the catholyte in an electrolytic cell, with the electrodes separated by an anion-permeable ion-exchange membrane, many metallic hydroxides tend to precipitate in the cathode compartment, to compensate for the loss of nitrate ions to the anolyte. For a trivalent cation, the overall reaction can be represented as follows:

$$R^{3+} + 3H_2O + 3e \rightarrow R(OH)_3 + 3H$$

With ferric nitrate as catholyte, however, the first-formed precipitate is dark brown, magnetic and contains only 3–4 per cent of water after drying at room temperature. On ignition at temperatures above 500° C., the product is rapidly converted to red, non-magnetic ferric oxide, in contrast to the mineral magnetite (Fe_3O_4), which retains its magnetism after similar treatment. The air-dried material contains a variable proportion of ferrous iron which is, on the average, ten times less than that expected from magnetite. The precipitate thus exhibits the same properties as maghæmite, which is closely related to synthetic gamma-Fe_2O_3.

It is surprising to find that an oxide of iron containing so little water can be prepared from aqueous solutions at room temperature. The majority of methods[1] for the preparation of gamma-Fe_2O_3 rely on the preliminary formation of the monohydrate (10·1 per cent water), with subsequent dehydration to the anhydrous magnetic oxide at 230–260° C. Good yields of maghæmite can be obtained by the electrolytic procedure, however, provided that the catholyte pH is maintained in the range 1·0–2·5. At higher pH values, ordinary ferric hydroxide (25·2 per cent water) is the main constituent of the precipitate.

We have also shown that ammonia, formed by cathodic reduction of nitrate, is not inimical to the formation of maghæmite and that the nature of the cathode (whether platinum or graphite) is not a critical factor.

Independent confirmation of the identity of the material has been obtained through the courtesy of Dr. A. D. Wadsley, of this Division, who has shown that the somewhat diffuse X-ray powder diffraction patterns can be indexed in terms of a primitive cubic lattice, the cell edge $a = 8·35 \pm 0·02$ A. falling within the range of maghæmite or gamma-Fe_2O_3. The patterns appear to be derived from a superlattice of the spinel grouping. While we make no claims that this superlattice may be caused by the systematic incorporation of water molecules or protons, it is of interest that the chemical composition of our material is not far removed from the formula HFe_5O_8 (2·2 per cent water), which is in good agreement with an earlier report[2] on superstructures in spinels.

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[1] See, for example, Brit. Pat. 640,438. Booth, H. S., "Inorganic Syntheses", **1**, 186 (McGraw-Hill, New York, 1939).
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Spiral Crystals of Magnesium Sulphate

In a communication in *Nature* of March 2, p. 493, there is a photograph of zinc sulphide crystals of spiral shape.

Fig. 1

I have observed crystals of similar form growing from saturated magnesium sulphate solution. The solution was made by saturating hot 5 *N* sulphuric acid solution with magnesium oxide, and filtering the reaction mixture into an evaporating basin. After the resulting solution had stood in the open for two days, it was observed that the bulk of the water had evaporated off, leaving a solid layer of magnesium sulphate, the surface of which was covered with a hairy network of crystals, some as much as half an inch long, and most of which terminated in a flat spiral (Fig. 1). Their thickness was in most cases less than that of a human hair. When examined under × 50 magnification, the curved crystals showed no sign of segmentation. The photograph was taken by B. G. Airlie and G. Davies. The distance between the top and bottom crystal in this enlargement was 6 mm.

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Role of Photons in a Self-Quenching Geiger-Müller Counter

A number of investigators have studied the spread of discharge along the anode of self-quenching Geiger-Müller counters, but the relative importance of photo-ionization of the gas and photo-emission from the cathode in such tubes has not yet been fully determined. The mechanism of the discharge spread along the anode is thus still under discussion[1].

We have carried out a set of direct experiments and have come to the following conclusions in an unambiguous manner, regarding the photo-emission from the cathode of a self-quenching counter: (1) photo-emission from the cathode is caused by ultra-violet as well as by visible radiations, but that due to the former is more pronounced; (2) photons are present over a much wider region around the anode wire than is usually believed.

In one set of experiments two identical coaxial counters, each 2·5 cm. in diameter, were placed in a glass tube facing each other 3 cm. apart. The filling was an argon–alcohol mixture at a total pressure of 10 cm. of mercury with 10 per cent alcohol. A gelatine filter 2-*B*, 2·5 cm. in diameter, or a thin glass disk of the same size could be introduced between the two counters when desired. The voltage of the Geiger-Müller tubes was supplied by two independent stabilized power units.

The pulses produced under normal working conditions of the two counters were fed into the coincidence unit (*AERE* type 1036-*B*) of resolving time one microsecond and the coincidence pulses were recorded in the scaler (*AERE* type 200-*A*) both with gelatine filter 2-*B* lying between the counters and without it.

It has been observed that the number of coincidences is always greater when there is no filter, and that it decreases in proportion to the path of photons intercepted by it as it is introduced in between the two counters. As the filter cuts out all ultra-violet radiations, we conclude that the coincidences obtained when the filter blocks the path of the photons between the two counters completely must be due to visible radiations produced in the counter avalanches. That these coincidences were not accidental or due to electric pick-ups was confirmed by separating the counters by about 60 cm., when not more than one coincidence was obtained per 3 min., even though the counting-rate in one counter was increased to about 1,500 counts per min. using a collimated gamma-ray source while there were about 200 counts per min. in the second.

It was further observed that the number of coincidences showed pronounced increase if the photons produced in the avalanches of one counter were reflected on the inner surface of the cathode of the second instead of allowing them to pass right through the body of the second counter and to strike against the glass envelope where the anode wire was sealed.

The number of coincidences with filter 2-*B* or the thin glass disk lying between the counters was found to be the same in any given interval of time, which indicated that no appreciable number of photons of wave-lengths in the range 3300–4000 A., the absorption limits of glass and gelatine filter respectively, was passing from one counter to the other under the conditions of these experiments.

Separate experiments were carried out to investigate the photo effect of visible radiations obtained from a light source on the cathode of a counter. We have observed that the photo-sensitivity of the counter varies linearly with the intensity of visible radiations at wave-lengths greater than 4000 A. The ultra-violet radiations below 4000 A. were cut down in these experiments with filter 2-*B* and the intensity of visible photons was varied by using neutral density filters supplied by Messrs. Kodak, Ltd., London.

A typical set of results is as follows: plateau lengths 200 V. and 260 V. Plateau slopes 0·05 and 0·025 per cent per volt.

Coincidences obtained per 5 min.: (1) without filter 2-*B*, 68; (2) with filter 2-*B*, 24; (3) with reflected photons, 155. These readings were reproducible for days within the limits of statistical variations.

Details of the experiments will be published elsewhere.

We are grateful to Sir John Cockcroft and Dr. D. Taylor, of the Atomic Energy Research Establishment, Harwell, for supplying the electronic equipment used in the investigation and for their interest. Our thanks

are also due to Prof. L. A. Du-Bridge, of California, for helpful discussion of this work.

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Vibration Packing of Dry Granular Solids

J. KOLBUSZEWSKI[1] has suggested that the porosity of a bed of sand grains formed by a single fall of the grains in air varies inversely with the velocity of fall. We have confirmed the generality of this observation and have extended it in experiments in which an existing bed of fine-grained dry solid is subjected to interrupted vibration.

In our experiments, a quantity of powder of less than 300 B.S. sieve (53μ aperture) size is contained in a glass measuring cylinder rigidly clamped to a relatively massive platform which is caused to oscillate in a vertical plane in a near approach to simple harmonic motion. The amplitude and frequency of oscillation can be varied at will to maxima of 0·4 in. and 2,000 cycles per min. The oscillation can be arrested at any point by adjustable stops. A system of strong, opposed, conical springs in the transmission prevents damage to the machine when the stops are used.

Two solids of different properties have been used, namely: (1) coal, an amorphous, porous, macromolecular material of specific gravity 1·30; (2) zircon, crystalline, non-porous, specific gravity 4·6.

Observations of the variation of the porosity of a bed with variation in the amplitude and frequency of oscillation and in the position in a cycle at which the downward progress of the cylinder and its contents is arrested by the stops have shown that the porosity is influenced by all these factors. The effects ascribable to amplitude and frequency variation depend upon the function of these in determining acceleration and velocity. The position and arresting action of the stops are significant in their selection of the velocity, and hence energy, of the mass of particles at the moment at which an exceedingly rapid deceleration, or dissipation of energy, is caused.

Fig. 1 epitomizes our experimental results, showing the relation between porosity and impact velocity, as determined by the settings of the three variables. The impact velocity defines the energy increment imparted to the mass of particles during the part of an oscillation preceding arrest. The graph includes values obtained at frequencies ranging from 100 to 1,600 cycles per min. and amplitudes of 0·05–0·35 in., with various positions of the stops.

In every experiment the bed quickly achieved a state of equilibrium not visibly altered by continuation or cessation of the treatment. The values of porosity recorded are equilibrium values. A spread of $\pm$ 1 per cent of porosity is evident but does not obscure the major trends.

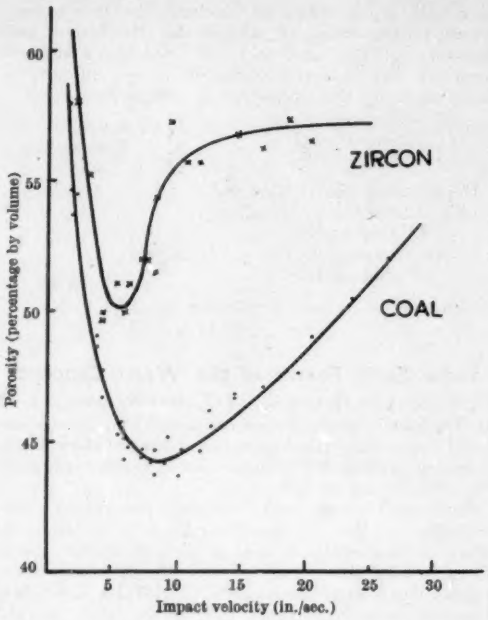

Fig. 1

Interrupted vibration results in the establishment of an equilibrium bed structure and porosity which are determined by the cyclic energy increment imparted to the bed and by the properties of the solid particles.

Low values of energy increment produce a bed of relatively high porosity. Increase of the increment value at first results in a progressive compaction. In this stage the energy increments absorbed by the bed overcome surface friction and other stabilizing forces involved in the mutual disposition of the particles until a new equilibrium is established. As a critical incremental value is approached a second type of effect absorbs an increasing proportion of the imparted energy. This results in a progressive loosening of the structure and an increase of porosity.

The rate of change of equilibrium porosity with change of energy increment is high, so that maximum packing is obtained only within a narrow range.

Our tentative hypothesis is that, as impact velocity is increased, elastic deformation of the constituent particles of a bed increases. Eventually, the vibration of the particles resulting from their elastic deformation dominates the trend towards compaction and the bed expands.

The material of low density (coal) showed no end-point to this second trend within the limits of our experiments; but the very dense zircon showed the establishment of a stable situation unaffected by further increase of energy increment. This may be the resultant of the vibration effect and the rapidity of settling of dense particles under gravity.

It is apparent that for each material the maximum packing is produced only by a critical value of impact velocity, or cyclic energy increment, which

may with equal effect be produced by any appropriate combination of amplitude, frequency and stop-setting. The time required to achieve equilibrium at any selected value of impact velocity is determined by the frequency of oscillation.

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Some Early Forms of the Weed Concept

At the third British Weed Control Conference held at Blackpool during November 5–8, 1956, discussions arose concerning the history of the word denoting a weed or undesirable plant. Some further remarks may be of interest here.

Although weeds were perhaps recognized individually in the ancient Near-Eastern civilizations there is little evidence that a word or words existed for the collective term 'weed'. Furthermore, most plants were considered useful. Dr. John A. Wilson (private communication) has stated that in the ancient Egyptian language *kaka*, commonly identified as the castor plant, *Ricinus communis* L., was used in figures of speech for a plant which grows rankly and may be used as fuel, and also that *senmit*, a word occurring only once in some such context as: "How unguarded speech grows like a *senmit* plant!" may well mean 'weed'.

Ebbell's detailed study[1] of the "Papyrus Ebers" (*c.* 1550 B.C.) identified large numbers of plants used principally as remedies and does include mustard and pond-weeds, and castor bean. Hieroglyphics have been isolated and identified for rush, rush with shoots, herb, reed, reeds side by side, etc.[2]. A recent study of a Sumerian tablet on agriculture from Nippur in Iraq (1700 B.C.) does, at least in a free translation, refer to clearing the field of weeds and stubble prior to crop planting[3]. Thompson's Assyrian botanical study[4] reveals no equivalents for weeds, however.

The last stage of Egyptian, Coptic, uses a word *enteg* (NTHσ) for the Greek ζιζάνια, *tares*, for example, Matthew xiii, 25, in the Bible (J. A. Wilson, private communication). 'Tares' in some translations of the Bible has been freely translated as 'weeds'. However, the latest authorities, Moldenke and Moldenke[5], identify this with darnel (*Lolium temulentum* L.)—a poisonous cereal weed known even to Theophrastus.

In Greek, the word βοτανη (botáne) means pasture, fodder, herb and then noxious herb and thus 'weed', and it was used by Theophrastus. The verb form here is βοτανίζω (botanizo), 'I weed'; while the nouns, βοτάνι and ἀγριοβότανον, are used in modern Greek (Gertrude Smith, private communication).

Early Roman writers employed several forms for the weed concept such as *herba* (Pliny); as "*officiant lactis ne frugibus herbae*" (Virgil); and *erunco herbas* (Columella). Both *runco* and *erunco* are used in the sense of weeding—having some affinity with *Runcina*, a rural deity of the Augustinian period supposed to preside over weeding. The phrase, *herba inutilis*, has also been used (Gertrude Smith, private communication).

One of the earliest treatises on weeds is that of Giovanni Lapi (1767)[6] on darnel or *Lolium temulentum* L. The author here quotes Virgil, ". . . *interque nitentia culta infelix lolium et steriles dominatur avenae*". The modern Italian forms, *malerba* and *pianti infestanti*, are self-descriptive, as also are the contemporary French, *mauvaises herbes*, *plantes nuisibles*, *plantes adventices*, and possibly *plantes vénéneuses*.

Ratzeburg[7] informs us that the German *Unkràt* was in use in the tenth century, and, of course, its relationship to the contemporary *Unkraut* is evident. With Germanic realism, precision, and finality the usage of *Unkraut* as opposed to *Kraut* needs no comment. The verb form only of *wieden* is retained in the Dutch language.

The Oxford English Dictionary (1933) traces the various spellings of our modern term from the first Anglo-Saxon recording of *weod* as used by Aelfred (*c.* 888), and *wiedes* (*c.* 1200) through renderings of *weodes* (*c.* 1290), *wedes* (1393), *weed* (*c.* 1440), *wides* (1532), to 'weed' again in 1592. Although novel, the possibility still should be considered that 'weed' might be derived from earlier forms of the German *weyt* (*c.* 1150), the Dutch *weet* (*c.* 1597) and *weeda*, the Belgian *wedt* (*c.* 1576), etc., for woad or dye-weed (*Isatis tinctoria* L.).

According to Long's "Common Weeds of Farm and Garden" (London, 1910) the earliest English work on agriculture to include our term was the usage of *wede* by John Fitzherbert in his "Boke of Husbandrye" (1523). The more illustrious Jethro Tull in his "Horse Hoeing Husbandry" of 1731 employs the modern form of 'weed'.

Hanzawa[8] has observed that the single Chinese ideograph for weed, *tsao* (herb), was adopted from a poem of Y. Kiang (Han Dynasty, 200 B.C.); while the later modified form *tza tsao* (miscellaneous herb) employing two characters first occurred in a Japanese work of early date.

In the ancient languages, as might logically be expected, the word for the most typical and outstanding example—in one case a poisonous weed of grain—also came to mean 'weed'; while in the later Greek and Latin the rather nondescript *herba* or its equivalent also came to mean weed—followed later by a refinement or a descriptive phrase generally including some form of *herba* or its equivalent. This has continued on into the modern forms in most of the Romance languages. The Germanic and its derivatives have evolved and retained the single noun—with the modern German word, at least, implying inedibility.

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FORTHCOMING EVENTS

Thursday, July 4

POLAROGRAPHIC SOCIETY (at the "Duke of York", 8 Dering Street, Mayfair, London, W.1), at 7 p.m.—Informal Discussion Meeting.

Friday, July 5

INSTITUTION OF ELECTRONICS (in the Beveridge Hall, The Senate House, University of London, W.C.1), at 6 p.m.—Dr. P. B. Fellgett: "The Theoretical Problems of Television Astronomy"; Mr. B. V. Somes-Charlton: "The 1956 Opposition of Mars".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER (graduate in medicine holding a higher surgical qualification) IN THE DEPARTMENT OF SURGICAL SCIENCE—The Secretary, The University, Edinburgh (July 3).

JUNIOR LECTURER IN PHARMACOLOGY—The Dean, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (July 5).

RESEARCH ASSISTANT to work on a project concerned with electronic equipment for the control of machine tools—The Registrar, The Manchester College of Science and Technology, Sackville Street, Manchester 1 (July 5).

UNIVERSITY LECTURER (preferably with qualifications in applied thermodynamics) IN MECHANICAL ENGINEERING in the University of Aberdeen and Robert Gordon's Colleges—The Secretary, The University, Aberdeen (July 5).

ASSISTANT, Grade B (graduate, with research or industrial experience) IN METALLURGY—The Principal, Derby and District College of Technology, Normanton Road, Derby (July 6).

ASSISTANT, Grade "B" (preferably with some experience in chemical engineering or photography) IN CHEMISTRY, to teach to general certificate of education advanced level and ordinary national certificate chemistry; and an ASSISTANT, Grade "B" IN BIOLOGY, to teach to general certificate of education advanced level—The Principal, Harrow Technical College, Station Road, Harrow, Middlesex (July 6).

ASSISTANT LECTURER (preferably with a knowledge of powder metallurgy) IN THE DEPARTMENT OF METALLURGY AND CHEMISTRY, Rotherham College of Technology—The Director of Education, Education Offices, Rotherham (July 6).

BIOCHEMICAL RESEARCH ASSISTANT (with postgraduate experience), for studies involving fractionation of tissue constituents and tissue metabolism—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5, quoting Ref. FP (July 6).

CHEMIST or PHYSICIST (with G.C.E. ("A"), H.N.C., or equivalent, and preferably some experience of spectrometry) at the Wantage Radiation Laboratory of the A.E.R.E., Harwell, for infra-red analysis of a wide range of natural and synthetic high polymers, and other compounds, prepared in work on uses of radiation industrial chemical processes—Group Recruitment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 816/34 (July 6).

EXPERIMENTAL OFFICERS (with a pass degree in botany or other suitable qualifications) IN CYTOLOGY, PLANT GENETICS, GRASSLAND AGRONOMY and CHEMISTRY—The Registrar, Welsh Plant Breeding Station, University College of Wales, Aberystwyth (July 6).

POST-DOCTORAL FELLOW IN CHEMISTRY, for work on organometallic compounds under the direction of Dr. P. L. Pauson—The Registrar, The University, Sheffield (July 6).

SENIOR LECTURER IN APPLIED PHYSICS at the Municipal College, Southend-on-Sea—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (July 6).

SENIOR LECTURER IN ORGANIC CHEMISTRY; a SENIOR LECTURER IN MATHEMATICS; and a SENIOR LECTURER IN ELECTRICAL ENGINEERING (preferably HEAVY CURRENT)—The Registrar, College of Technology, Suffolk Street, Birmingham (July 6).

ASSISTANT CURATOR, GROUNDS AND GARDENS (with extended training at an agricultural college or farm institute or a recognized botanic garden), for duties which will include the hiring and supervision of landscape gardening labour and responsibility for maintaining and using mechanical equipment—The Assistant Registrar (London), University College of Ghana, 20 Tavistock Square, London, W.C.1, or The Registrar, University College of Ghana, Achimota, Accra (July 8).

BRITISH COKE RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY, to investigate the carbonization of high polymers and related materials and to examine the physical and chemical properties of cokes and activated carbons—The Registrar, The University, Hull (July 8).

LECTURER IN AGRICULTURAL BIOCHEMISTRY—The Secretary, The University, Aberdeen (July 9).

ASSISTANT LECTURER (with qualifications in either pure or applied mathematics) IN MATHEMATICS—The Registrar, The University, Manchester 13 (July 10).

ASSISTANT (with an honours degree in bacteriology or equivalent, together with postgraduate experience) IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (July 12).

COURTAULDS FELLOWS (2) (with a good honours degree in physics, chemistry or chemical engineering) to work under the direction of the Head of the Department of Textile Chemistry—The Registrar, Manchester College of Science and Technology, Manchester 1 (July 12).

LECTURER IN LOGIC AND METAPHYSICS in St. Salvator's College—Joint Clerk to the University Court, College Gate, St. Andrews (July 13).

EXPERIMENTAL OFFICERS (3) (graduates) IN THE BEE DEPARTMENT, for work on (*a*) bee diseases; (*b*) field behaviour of bees; and (*c*) the social organization of bee communities—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (July 15).

LECTURER IN THE DEPARTMENT OF PATHOLOGY—The Secretary, The University, Edinburgh (July 15).

SCIENTIFIC OFFICER (with a first- or second-class honours degree in microbiology, or a first- or second-class honours degree which included chemistry and biology, followed by a postgraduate diploma in bacteriology) AT THE WATER POLLUTION RESEARCH LABORATORY (D.S.I.R.), Stevenage, Herts, for research on bacterial problems connected with the treatment of sewage and trade wastes and pollution of rivers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.180/7A (July 15).

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physical or inorganic chemistry or metal physics) IN THE CHEMICAL RESEARCH LABORATORY (D.S.I.R.), Teddington, for the study of oxidation and mechanism of atmospheric corrosion of metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.743/6 (July 15).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or equivalent) IN THE DEPARTMENT OF POTATO GENETICS, to assist in the breeding of a selection of potato varieties resistant to blight and to virus diseases—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (July 17).

LECTURER IN THE DEPARTMENT OF ZOOLOGY, University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, July 20).

ASSISTANT (with some knowledge of freshwater biology and chemistry) IN THE FISHERIES AND POLLUTION DEPARTMENT, Somerset River Board, for duties which will include the inspection of sewage works and trade waste treatment plants, river surveys, and the examination of samples—The Chief Engineer, Somerset River Board, The Watergate, West Quay, Bridgwater, Somerset (July 22).

RESEARCH AGRICULTURALIST for a study in the use of farm motive power, with particular reference to fuel economy and associated aspects of farm management—The Registrar (Room 9, O.R.B.), The University, Reading (July 22).

LECTURERS (2) (with an interest in observational science or fluid dynamics) IN THE METEOROLOGY DEPARTMENT—Prof. P. A. Sheppard, Imperial College, London, S.W.7 (July 27).

LECTURER IN BACTERIOLOGY—The Secretary of University Court, The University, Glasgow (July 31).

LECTURER IN BOTANY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

CATTLE PHYSIOLOGIST (with a university honours degree in science or agricultural science or a degree in veterinary science or equivalent qualifications, together with postgraduate research experience in physiology or biochemistry) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION (C.S.I.R.O.), National Cattle Breeding Station, near Rockhampton, Queensland, to initiate research into biochemical problems related to physiological and metabolic differences between breeds of cattle—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 231/4 (August 10).

CHAIR OF AGRICULTURE in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (August 15).

LECTURER IN NATURAL HISTORY (ECOLOGY)—The Secretary, The University, Aberdeen (August 31).

LECTURER IN NATURAL PHILOSOPHY (PHYSICS), for work in the Medical Physics Unit—The Secretary, The University, Aberdeen (August 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Principal, St. David's College, Lampeter.

ASSISTANTS (women, with a good knowledge of Italian, Spanish or Portuguese, and preferably with an interest in biology), for (*a*) the preparation of the insect section of the *Zoological Record*, an annual record of the world literature in entomology; or (*b*) abstracting scientific papers in economic entomology—The Director, Commonwealth Institute of Entomology, 56 Queen's Gate, London, S.W.7.

LECTURER, Grade B (with a general science degree in chemistry and physics and a diploma in education, or its equivalent with teaching experience) IN THE DEPARTMENT OF HEALTH EDUCATION—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

LECTURER (with a sound knowledge of statistics) TO TEACH MATHEMATICS to B.Sc. Engineering and General Degree levels; and a Grade B ASSISTANT TO TEACH MATHEMATICS for Craft and National Certificate courses in Engineering—The Registrar, College of Technology and Commerce, Leicester.

MATHEMATICIANS, AERODYNAMICISTS and AERO-ENGINEERS (with, or obtaining, first- or second-class honours degree in mathematics or engineering or equivalent) at a Ministry of Supply Experimental Establishment, for duties which include research and investigation into problems of aircraft performance, stability and control; the application of mathematical techniques to problems relating to aerodynamics, structure, navigation, armament, etc., and assessment in connexion with performance estimation of new types of aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.421/6A.

READER (with high academic qualifications and the ability to promote research and to organize and conduct postgraduate lecture courses) IN APPLIED MECHANICS in the Department of Civil and Mechanical Engineering—The Clerk to the Governing Body, Battersea College of Technology, London, S.W.11.

RESEARCH ASSISTANT (with a good engineering or science degree, or equivalent) IN THE DEPARTMENT OF AERODYNAMICS, for work in the field of powered lift as applied to wings of low aspect ratio—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

RESEARCH ASSISTANTS (graduates in physics, chemistry or mathematics)—Northern Polytechnic, Holloway, London, N.7.

SCIENTIFIC OFFICER (CHEMIST) IN THE METROPOLITAN POLICE LABORATORY—The Secretary, Room 165, New Scotland Yard, London, S.W.1.

SENIOR CHEMICAL ENGINEER, Principal Scientific Officer grade (with a first- or second-class honours degree in chemistry or chemical engineering (or equivalent), and not less than seven years postgraduate experience), to serve as a deputy to the Head of a Chemical Engineering Development Section—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting C/1169/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bulletin of the British Museum (Natural History). Entomology. Vol. 5, No. 2: New Genera and Species of Ethiopian, Mascarene and Australian Reduviidae (Hemiptera-Heteroptera) in the British Museum (N.H.), London. By N. C. E. Miller. Pp. ii+29–81. 15s. A Short Guide to the Exhibition Galleries of the Natural History Museum. Fifth edition. Pp. vi+30. 1s. 6d. (London: British Museum (Natural History), 1957.) [135

University of Reading: Museum of English Rural Life. Report 1956. Pp. 16. 1s. A History of Whiteknights. By Dr. Ernest Smith. Pp. iii+32 (4 plates). 5s. 6d. (Reading: The University, Museum of English Rural Life, 1957.) [135

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1956. No. 5: Symposium on Techniques in Polymer Science. With an introduction by Dr. C. H. Bamford. Pp. iii+80. (London: Royal Institute of Chemistry, 1957.) 7s. 6d.; 1.15 dollars. [135

British Electrical and Allied Industries Research Association. Technical Report L/T338: Polarization of the Continuous Spectrum in a Gas Discharge. By B. V. Paranjape. Pp. 6. 6s. Technical Report L/T342: On the Polaron Rest Energy and Effective Mass. By G. R. Allcock. Pp. 40. 21s. Technical Report U/T135: Oscillographic Observation of Short Duration Arcs between Separating Platinum and Palladium Contacts. By J. Riddlestone. Pp. 12+5 figures. 12s. 6d. (Leatherhead: British Electrical and Allied Industries Research Association, 1955 and 1956.) [135

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Local Government: Functions of County Councils and County District Councils in England and Wales. Pp. 10. (Cmnd. 161.) (London: H.M. Stationery Office, 1957.) 8s. [135

Ministry of Education: Science Museum. Books on Engineering: a Subject Catalogue of Books in the Science Library. Pp. x+183. (London: H.M. Stationery Office, 1957.) 16s. net. [135

Polish Cultural Institute. Selective Quarterly Guide to Polish Periodical Literature, Vol. II, 2, April, 1957. Pp. ii+63. (London: Polish Cultural Institute, 1957.) [135

National Institute of Oceanography. Collected Reprints, Vol. 4. Reprints Nos. 125–162. (Wormley, near Godalming: National Institute of Oceanography, 1956.) [135

Medical Research Council Special Report Series No. 294: Individual Differences in Night-Vision Efficiency. By M. H. Pirenne, F. H. C. Marriott and E. F. O'Doherty. With a section on The Frequency of Seeing at Low Illumination, by H. K. Hartline and P. R. McDonald. Pp. viii+83+1 plate. (London: H.M. Stationery Office, 1957.) 8s. net. [225

Government of Northern Ireland: Ministry of Agriculture. Leaflet No. 41: Blackleg Disease in Cattle. Pp. 2. Leaflet No. 60: Agricultural Classes. Pp. 7. Leaflet No. 103: Crops for Idle Land. Pp. 2. Leaflet No. 130: The Cultivation of Lettuce. Pp. 11. (Belfast: Ministry of Agriculture, 1957.) [225

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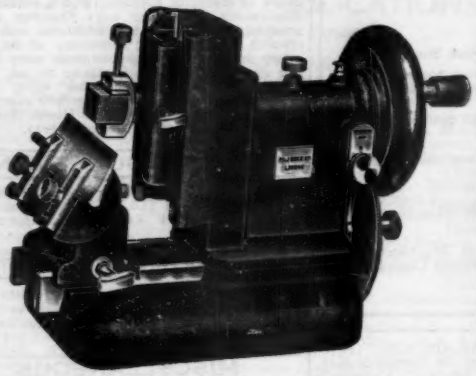

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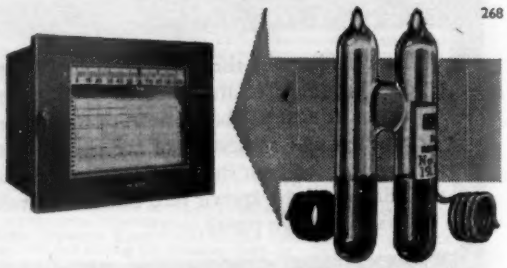

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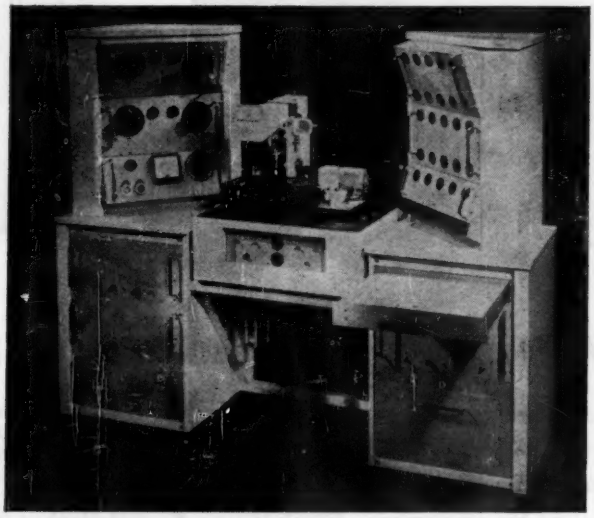

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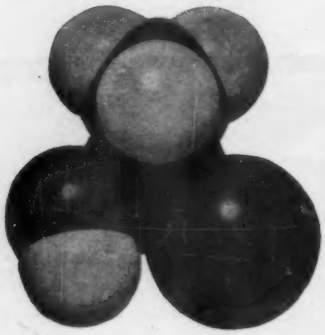

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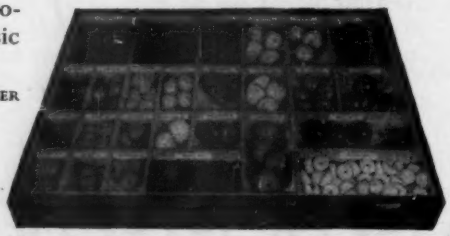

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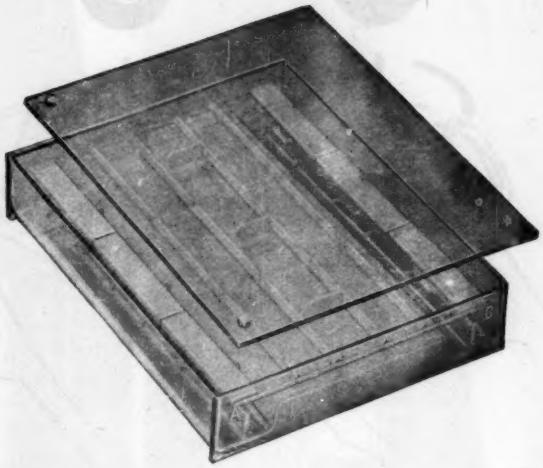

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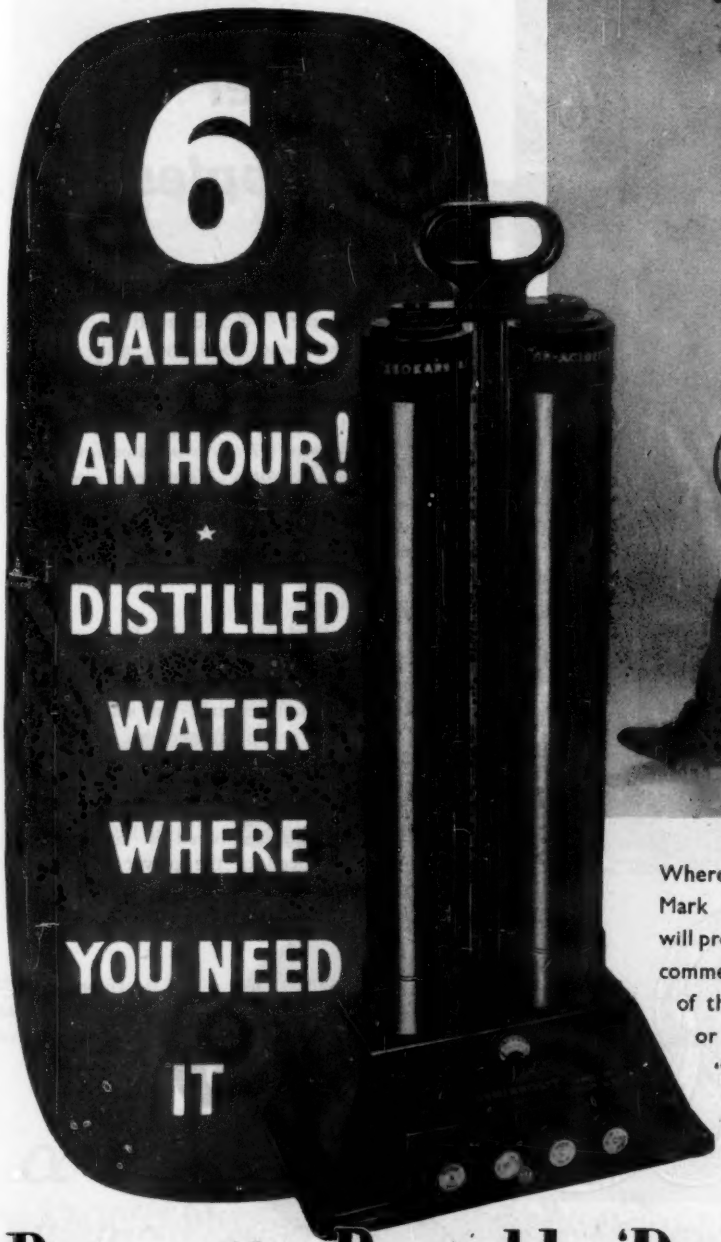

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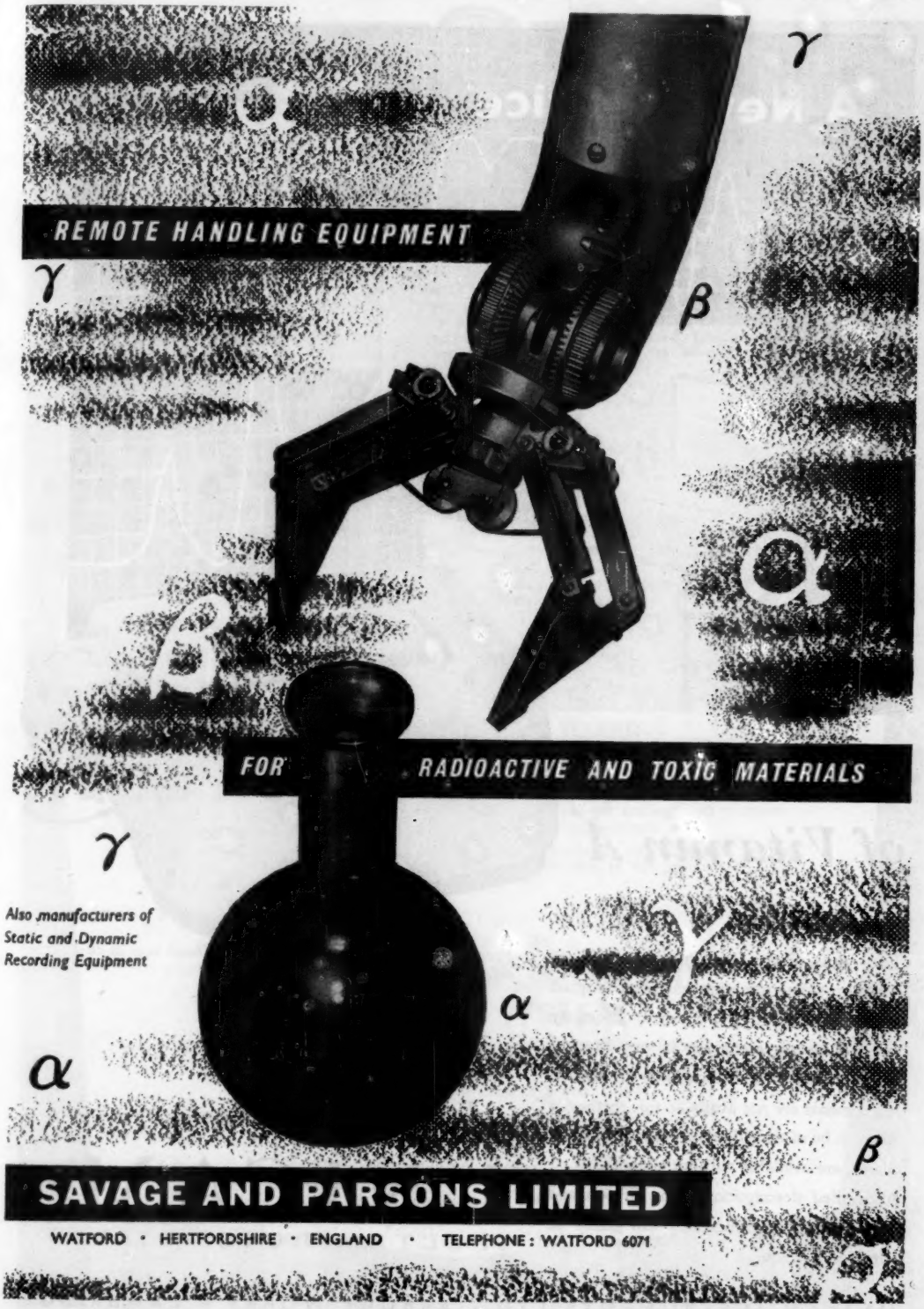
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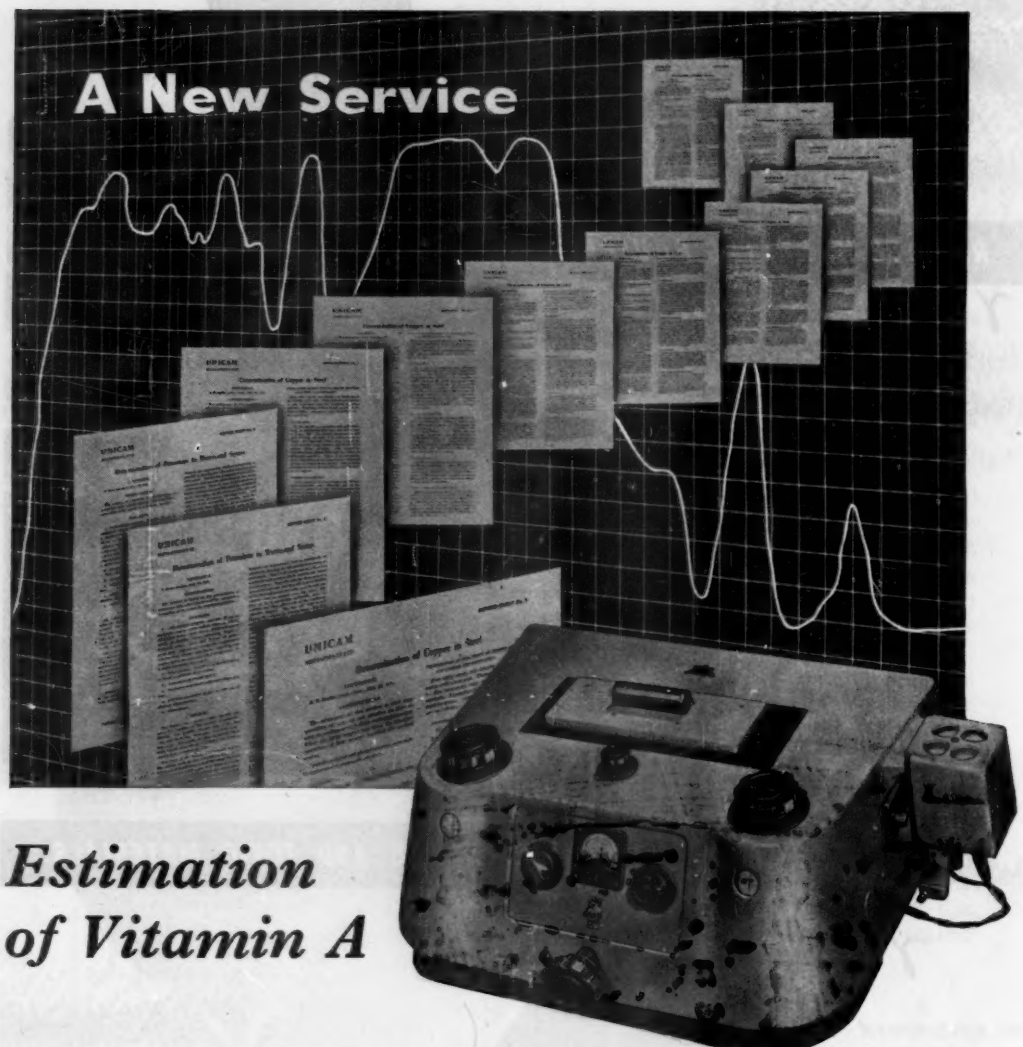

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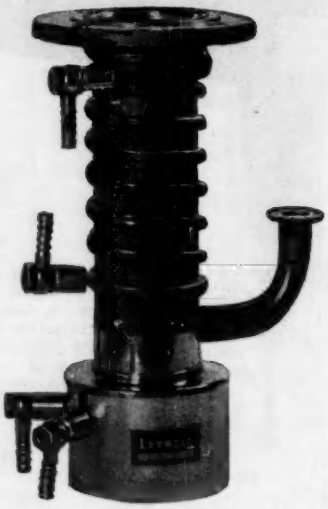

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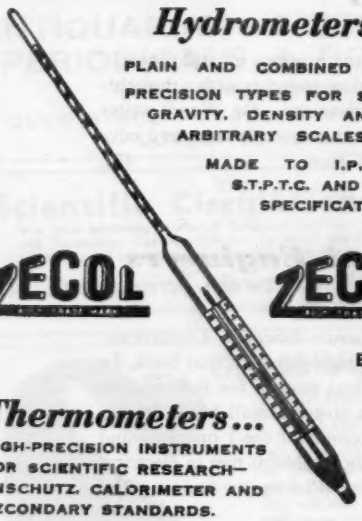

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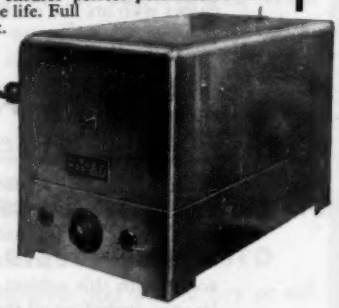

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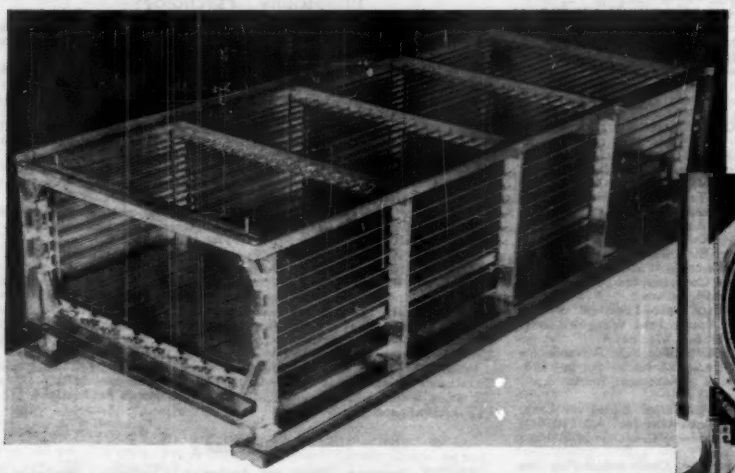

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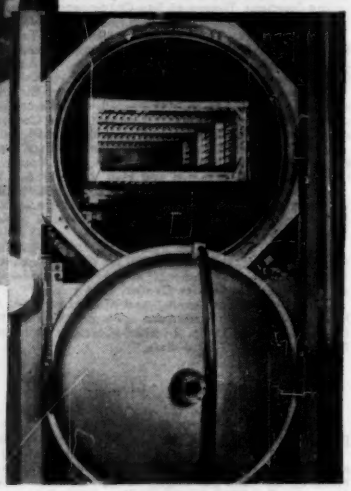

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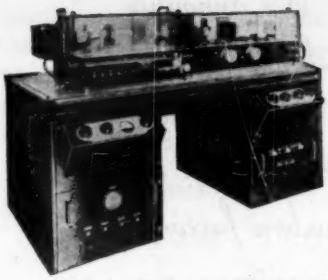

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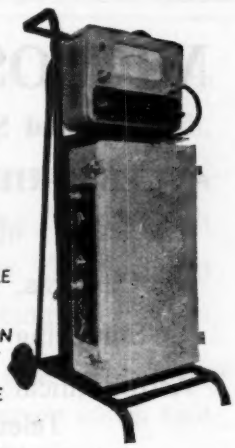

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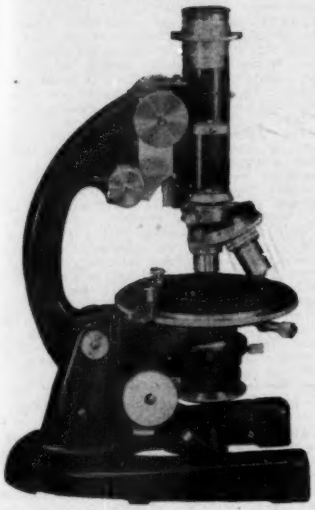

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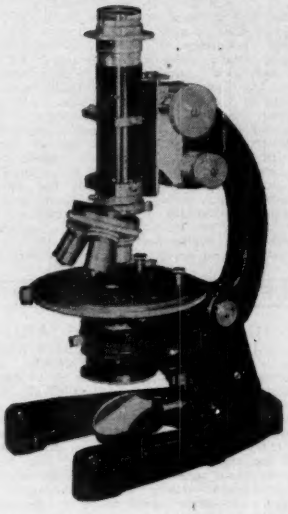

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THE GOVERNMENT OF IRAQ INVITES applications for the vacant posts of Economic Botanist and Ecologist in the Ministry of Agriculture at Baghdad in connection with a current survey of the natural vegetation of Iraq and its economic exploitation. The officials appointed to these posts will be based at Baghdad but will be expected to spend a considerable part of their time in the field in all parts of the country. Travelling allowances sufficient to cover out-of-pocket expenses and transport will be provided by the Government when on official duty away from base. Salaries according to age, qualifications and experience within the range D.150-D.200 per mensem (one Iraqi dinar equals £1 sterling), plus high cost of living bonus (at present rate about D.12 per mensem). The official will be expected to contribute five per cent of his monthly salary to a provident fund to which the Government will likewise contribute a sum equal to ten per cent of his monthly salary, the dues from this fund being payable to the official at the end of his contract. Period of service: two years (subject to a probationary period of six months), renewable by mutual agreement for a further period of one year. Leave at the rate of one day's leave earned for every five days of effective service. Cost of official's passage from his country of origin to Iraq on first appointment and back home at the end of his contract will be defrayed by the Government.—Candidates should write to the Director-General of Agriculture, Baghdad, stating full name, date and place of birth, nationality, religion (also father's full name and nationality at birth and mother's maiden name and nationality at birth) and giving a brief outline of their education, academic distinctions (date and subject of graduation) and of their subsequent career, mentioning the posts they have previously held, the salary of their present post, and the salary they are now asking. Applications should be accompanied by references from at least two qualified authorities.

UNIVERSITY OF CAPE TOWN
SOUTH AFRICA

Applications are invited for a Lecturer in the Department of Psychology. Preference will be given to a candidate with previous experience of university lecturing in general experimental psychology. Good facilities for research in experimental, clinical, and educational psychology are available in the Department, and the University has its own Child Guidance Clinic under the direction of a senior member of the staff. The salary scale is £850 by £50 to £1,200 per annum. There is also a temporary cost of living allowance for a married man (at present £234 per annum).

Applications (with copies of testimonials) should state age, experience, qualifications, and research work completed or in progress, and give the names of two referees whom the University may consult. Two copies of the application and testimonials should reach the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (from whom memoranda giving the general conditions of appointment and further information about the work of the department should be obtained), not later than July 20, 1957. An additional copy should be sent direct by airmail to the Registrar, University of Cape Town, Private Bag, Rondebosch, Cape Town, South Africa, by the same date. The University reserves the right to appoint a person other than one of the applicants or to make no appointment.

UNIVERSITY OF CAPE TOWN
SOUTH AFRICA

Applications are invited for a Lectureship in the Department of Zoology. The minimum qualification is an honours B.Sc. The successful applicant will be expected to lecture in zoology and comparative physiology to degree standard. Experience in teaching and research in these fields would be an additional recommendation. The successful applicant would be expected to assume duty on February 1, 1958. The salary scale is £850 by £50 to £1,200 per annum. There is also a temporary cost of living allowance for a married man (at present £234 per annum).

Applications (with copies of testimonials) should state age, experience, qualifications, and research work completed or in progress, and give the names of two referees whom the University may consult. Two copies of the application and testimonials should reach the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (from whom memoranda giving the general conditions of appointment and further information about the work of the Department of Zoology should be obtained) not later than July 20, 1957. An additional copy must be sent direct by airmail to the Registrar, University of Cape Town, Private Bag, Rondebosch, Cape Town, South Africa, by the same date. The University reserves the right to appoint a person other than one of the applicants or to make no appointment.

UNIVERSITY OF WESTERN AUSTRALIA

Applications are invited for the post of Reader in Operative Dentistry. The applicant must hold a degree in dental science which is registrable by the Dental Board of Western Australia. In addition, he should hold a senior dental qualification. The salary range for Readers is £A.2,200 to £A.2,400 per annum plus cost-of-living allowance (at present £43 per annum), and the commencing salary will be determined on the basis of the qualifications and experience of the appointee. An allowance is made towards travelling expenses, and housing assistance is available.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. The closing date for the receipt of applications, in Australia and London, is August 5, 1957.

UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Assistant Lecturer or Lecturer in Chemistry, with special interests in physical chemistry, to begin duties on October 1, 1957, or as soon as possible thereafter. New salary scales are being introduced and are expected to be: Assistant Lecturer, £700 by £50 to £850; Lecturer, £900 by £50 to £1,350 by £75 to £1,650, with F.S.S.U. provision and family allowance. Initial salary according to qualifications and experience.

Further particulars should be obtained from the Registrar, to whom applications (three copies) should be sent by July 13, 1957.

ATOMIC ENERGY IN MEDICINE

By K. E. HALNAN, M.D., D.M.R.T. 15s.

Written for readers not necessarily having much knowledge of either physics or medicine, the first book in the "Atoms for Peace" series will be found widely useful as an introduction to an important new field of medical therapy.

The increasing use of radiation emitted by the waste products from nuclear reactors in combating cancer and other growths (and its potential danger to all kinds of living tissue) is covered clearly and authoritatively, as are the revolutionary uses of radioisotopes in treatment and diagnosis. Certain techniques described are still on trial in one or only a few hospitals.

CHEMISORPTION

Edited by W. E. GARNER, C.B.E., D.Sc., F.R.S. 50s.

This volume contains the papers read, and the ensuing discussions, at the 1956 symposium on "Chemisorption" held at the University of North Staffordshire under the auspices of the Chemical Society of London.

The papers are divided into five sections:

1. The theory of chemisorption.
2. Chemisorption on insulators.
3. Chemisorption on metals.
4. Chemisorption on carbon.
5. Chemisorption on semi-conductors.

Each section is followed by a discussion, and the scope of the conference was deliberately restricted in order that these might be as full as possible.

COMBUSTION RESEARCHES AND REVIEWS 1957

Edited by AGARD *Combustion and Propulsion Panel, NATO* 40s.

The second volume of AGARD COMBUSTION RESEARCHES AND REVIEWS contains specialised combustion papers originating in five of the NATO countries.

The ten papers review new researches into flames, theoretical combustion, pulse-jets and the determination of physico-chemical and thermodynamic data required in combustion research.

ANALYSIS

A series of papers reprinted from *Research*, Vol. 9, 1956. 8s. 6d.

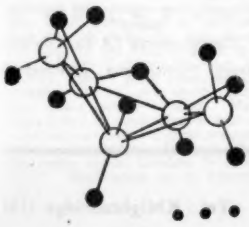
These nine papers form a survey of the newer methods now widely employed for analytical work, outlining the advantages and limitations of these techniques and of the instruments now available. A discussion of the most noteworthy advances made in classical methods of chemical analysis during the past two decades is included.

OPERATIONAL RESEARCH

A series of papers reprinted from *Research*, Vol. 9, 1956. 6s. 6d.

Operational research has been defined as a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control.

These papers reflect the growing importance of a new technique capable of achieving the integration of production and administration, the separation of which might well prove one of the country's gravest industrial problems of the near future.

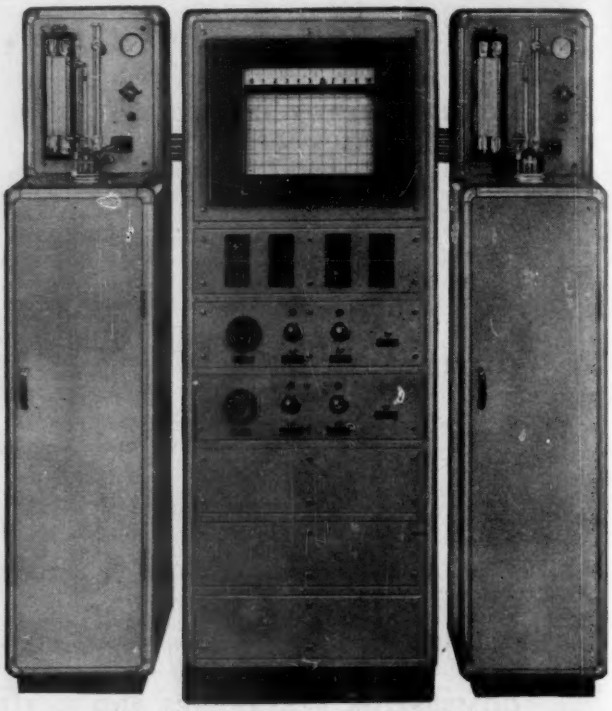


Descriptive leaflets, giving complete lists of contents, available from:

BUTTERWORTHS SCIENTIFIC PUBLICATIONS

88 Kingsway, London, W.C.2

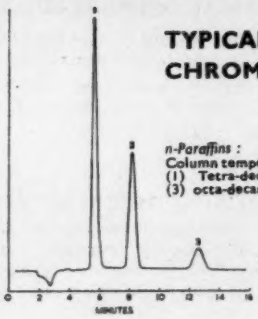
SHANDON-N.B.CO. FLAME CHROMATOGRAPH



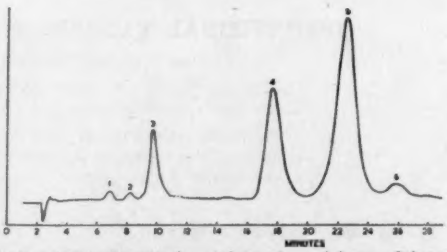
Here are a few of the special advantages of this outstanding new apparatus for gas chromatography essential to modern industry :

1. Extreme sensitivity. 0.1 μg. of benzene per ml. of hydrogen can easily be detected.
2. Less than 0.2 ml. dead space between the column and the jet on the detector ensures maximum resolution and efficiency.
3. Extremely high sensitivity enables small samples to be used, e.g., for a six-component mixture a 200 μg. sample is sufficient for a complete analysis.
4. Sensitivity independent of operating temperature.
5. Substances with boiling points up to 375° C. can be dealt with.
6. No weighing or previous calibration of the original charge is necessary for a complete quantitative analysis.
7. Sensitivity can be varied, even during a run, without causing base-line shift. By increasing sensitivity small peaks can be "blown up" for accurate measurement; reducing sensitivity enables the major peaks to be kept within the recorder's chart range.
8. Up to four analyser units incorporating different columns and running at different operating conditions may be operated from one control unit.
9. Completely self-contained analyser units are available for use with a suitable existing recorder.

TYPICAL CHROMATOGRAMS



n-Paraffins : Column charge 1.5 mg. Column temperature 300° C. *Constituents:* (1) Tetra-decane ; (2) hexa-decane ; (3) octa-decane.



Peppermint Oil (American) : Column charge 1.4 mg. Column temperature 176° C. *Constituents :* (1) (2) (3) Terpenes ; (4) Menthone ; (5) Menthol ; (6) Menthol Acetate.

SHANDON

SHANDON SCIENTIFIC CO. LTD., 6 Cromwell Place, London, S.W.7. Tel.: KNightsbridge 1131

CE15

SHEFFIELD REGIONAL HOSPITAL BOARD

SHEFFIELD NO. 4 HOSPITAL MANAGEMENT COMMITTEE
RADIOTHERAPY CENTRE
ASSISTANT PHYSICIST

Applications are invited for two appointments in the Physics Department of the Sheffield National Centre for Radiotherapy. (a) Appointment in the Principal Grade for Physicist with wide experience of hospital physics work. The successful candidate will act as Deputy to the Chief Physicist. (b) A second appointment in the Senior or Basic Grade, according to qualification and experience. Salary according to the Whitley Council Scales.

Applications, with names of at least two referees, should be sent to the Secretary, "Broom Cross," Tree Root Walk, Sheffield, 10, within 14 days of the appearance of this advertisement. Further particulars may be obtained on application to the Secretary.

COLLEGE OF TECHNOLOGY

BIRMINGHAM
(Designated College of Advanced Technology)

Applications are invited for the following posts: Senior Lecturer in Organic Chemistry; Senior Lecturer in Mathematics; Senior Lecturer in Electrical Engineering (preferably Heavy Current); Senior Lecturer in Building and Civil Engineering. Candidates should have appropriate academic and professional qualifications, industrial and/or research experience, while teaching experience will be an advantage. Salary in accordance with the Burnham (Further Education) Scale as follows: Senior Lecturers (men), £1,350 by £50 to £1,550; (women), £1,080 by £40 to £1,240 (plus equal pay increment).

Further particulars and forms of application from the Registrar, College of Technology, Suffolk Street, Birmingham, 1, on receipt of stamped, addressed foolscap envelope. Applications to be received within 18 days of this advertisement.

K. R. PILLING,
Clerk to the Governing Body.

SENIOR EXPERIMENTAL OFFICERS. THE Civil Service Commissioners invite applications for pensionable posts: (a) Ministry of Agriculture, Fisheries and Food; (b) Department of Scientific and Industrial Research; (c) Ministry of Supply. Age at least 31 on December 31, 1957. Candidates must have a university degree, or a professional qualification or higher national certificate in appropriate subjects. A higher school certificate (or equivalent), with mathematics or science as the principal subject may for some posts also be accepted. Candidates exceptionally well qualified by experience may be admitted without the academic qualifications. For all posts several years' appropriate experience is required. Under (a)—one post. Duties: to take charge of two experimental kitchens—candidates must have a sound knowledge of cooking, nutrition, and food chemistry. Organizing and lecturing ability and experience of large-scale catering necessary. Under (b)—five posts: Two are at the Road Research Laboratory, Harmondsworth—one for work in connection with the civil engineering services of the Laboratory and the other for editing work and the preparation of bibliographies, in collaboration with the senior scientific staff of the Laboratory, on matters of road-making materials and traffic and road safety; one at the Mechanical Engineering Research Laboratory at East Kilbride, near Glasgow; one at the Hydraulics Research Station, Wallingford, Berks, to take charge of the experimental work on problems connected with open-channel flow; one in London in the Technical Information Unit, for which a reading knowledge of German and experience in a technical records section is desirable. The 15 posts for (c) are classified under Applied Mathematics, Physics, Aeronautical, and Mechanical Engineering, Electrical Engineering for work on guided weapons, electronics, aircraft equipment, etc. Some posts require knowledge of chemical engineering, applied physiology (clothing), and metal corrosion. Posts requiring experience of technical information work for which candidates may apply irrespective of scientific background may also be included. Full information about the scope of the work is given in the memorandum. Salary (London) minimum £1,285 (women £1,191). Men's scale maximum £1,530. Exceptionally, starting pay above minimum. Somewhat lower outside London. Women's scale is being raised to reach equality with men's by 1961. —Application forms and memorandum from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4713/57/10. Applications to be returned by July 31, 1957.

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG, SOUTH AFRICA

Applications are invited for the positions of Senior Lecturer and Lecturer on the staff of the Department of Electrical Engineering. Senior Lecturer: Applicants must be able to teach electrical machine theory, power circuit theory, and to give laboratory instruction in the electrical machine theory. The Department has facilities for research in electrical machines and in high voltage electrical engineering. Lecturer: Applicants must be able to teach general telecommunications and network theory, and electromagnetic theory. He will also be required to give laboratory instruction in the telecommunications and electronics laboratories. Salary scales: Senior Lecturer, £1,200 by £50 to £1,500 per annum; Lecturer, £850 by £50 to £1,200 per annum. Cost-of-living allowance: Payable in terms of Union Government regulations to persons with dependants. The present rate for a married man is £234 per annum. Membership of the University Institutions' Provident Fund is compulsory and involves a contribution at the rate of 7 per cent of the salary paid. Membership of the staff medical aid fund is obligatory in the case of an officer who is eligible for membership in terms of the rules of the fund.

Applicants are advised to obtain a copy of the information sheet relating to these vacancies from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close in South Africa and London on August 12, 1957.

CHEMISTS

are required by the
ATOMIC ENERGY RESEARCH ESTABLISHMENT
at HARWELL and at WOOLWICH

to use excellent experimental facilities for investigations in these fields: SPECTROSCOPY; POLAROGRAPHY; RADIOCHEMISTRY; RADIATION CHEMISTRY; CHEMISTRY OF REACTORS.

Salary: (a) £940 rising to £1,155 (age 26 and over); (b) £375 (at 18) rising to £815.

A degree and/or considerable experience is desirable for (a); G.C.E. ("A" level) or equivalent is required for (a) and (b).

Sent postcard, quoting 804/34 (for posts at Woolwich) or 805/34 (for posts at Harwell), for full details and an application form, which must be returned by July 13, 1957, to the Group Recruitment Officer, A.E.R.E., Harwell, Didcot, Berks.

UNIVERSITY OF WESTERN AUSTRALIA

Applications are invited for the position of Lecturer in Electrical Engineering. Applicants should hold a degree in engineering and preference will be given to an applicant with experience or interest in some aspect of heavy power electrical design. The salary range for Lecturers is £A.1,250 to £A.1,750 per annum plus cost-of-living allowance (at present £43 per annum); the commencing salary will be determined on the basis of the qualifications and experience of the appointee. An allowance is made towards travelling expenses and housing assistance is available.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. The closing date for the receipt of applications, in Australia and London, is August 14, 1957.

UNIVERSITY OF MALAYA

SINGAPORE

Applications are invited for appointment to the first Chair of Agriculture. Salary between £2,268 and £2,548 per annum, at fixed point determined by qualifications and experience. Allowances: expatriation £378 per annum, cost of living £210 to £560 per annum. All paid in Malayan currency. Passages for appointee, wife, and children under 12 years. Part-furnished quarters at reasonable rent. Provident fund scheme.

Detailed applications (eight copies), naming three referees, by August 15, 1957, to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

COMMONWEALTH of AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
DIVISION OF FISHERIES AND OCEANOGRAPHY
APPOINTMENT NO. 320/115 OF CHEMICAL OCEANOGRAPHER

Applications are invited for appointment to a position of Chemical Oceanographer with the Organization's Division of Fisheries and Oceanography located at Sydney, New South Wales. The appointee will be required to take part in a research programme on the identification, characterization, and movements of water masses in the Tasman and Coral Seas. The existing programme uses the classical properties of temperature and chlorinity to identify water masses, but investigations are being conducted into the possibility of using total phosphorus, trace elements, sediment load, and optical properties to provide independent verification of origin and history; consideration is also being given to the structural features and nutrient distribution along water mass boundaries. A chlorinity-temperature-depth recorder has been developed and is being used to study such structural features *in situ* and efforts will be made to use physical instrumentation for the shipboard determination of dissolved oxygen and trace elements. The appointee will also be expected to study the hydrological structure of ocean current boundaries in the Tasman and Coral Seas and to develop a programme for the general investigation of trace elements in the sea. Applicants should possess a university honours degree in science with chemistry as a major subject, and also including physical chemistry and mathematics, or equivalent qualifications, together with post-graduate research experience preferably in chemical oceanography. Dependent upon qualifications and experience, commencing salary will be determined within the salary range of Research Officer, £A.1,313 to £A.1,938 per annum. First-class sea fares to Australia will be paid for the appointee, his wife, and family. The appointment will be conditional upon a satisfactory medical examination, and the appointee will be required to contribute to, and eligible to receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Account. Dr. G. F. Humphrey, Chief of the Division of Fisheries, will be in the U.K. during August to September to interview suitable applicants.

Applications, quoting Appointment No. 320/115 and stating full name, place, date and year of birth, marital state, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials, and the names and addresses of at least two persons willing to act as referees, if required, should reach the undersigned by August 9, 1957.

A. SHAVITSKY,
Chief Scientific Liaison Officer.
Australian Scientific Liaison Office,
Africa House, Kingsway,
London, W.C.2.

UNIVERSITY OF CAMBRIDGE

Applications are invited for a University Lectureship in Philosophy of Science tenable from October 1, 1957, or as soon as possible thereafter. Stipend (under review) on scale £900 to £1,500, with F.S.S.U. arrangements and family allowances.

Further particulars may be obtained from Mr. J. D. Irwin, The Old Schools, Cambridge, to whom applications should be sent so as to reach him not later than July 13, 1957.

SESSIONAL INSTRUCTORSHIPS

Applications are invited for Sessional Instructorships in chemistry at $2,400 for eight months. Besides doing some laboratory instructing, candidates will do graduate work towards the M.Sc. or Ph.D. degrees in chemistry.

Applications for the 1957-58 session should be made before August 31 to the Chairman, Department of Chemistry, University of Alberta, Edmonton, Alberta, Canada.

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE-UPON-TYNE

The Council of King's College invite applications for a Temporary Lectureship in Crop Husbandry. The appointment will be for the academic year 1957-58, and the salary will be determined in accordance with the qualifications and experience of the person appointed.

Applications, together with the names of three referees, should be submitted to the undersigned as soon as possible.

G. R. HANSON,
Registrar of King's College.

IMPERIAL CANCER RESEARCH FUND

The Council invite applications for a new post of

DIRECTOR OF RESEARCH

He will be responsible for the initiation and direction of all cancer research in the Fund's laboratories. Their choice will not be limited to those who may make formal application and the Council reserve the right to fill the post by invitation.

The Fund is about to erect a modern laboratory block next to the Royal College of Surgeons in Lincoln's Inn Fields, London, and the Director will be required to assist in the planning of these laboratories and to take charge when complete. He should be medically qualified and well acquainted with the field of cancer research.

The Director's salary will be at least £4,000 per annum with appropriate children's allowances and membership of the F.S.S.U.

Further particulars and terms of appointment may be obtained from the Secretary, by whom applications must be received on or before November 1, 1957.

KENNEDY CASSELS.
Secretary.

Royal College of Surgeons of England,
Lincoln's Inn Fields,
London, W.C.2.

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

SHAKESPEARE STREET, NOTTINGHAM

Applications are invited from honours graduates for appointment to the post of Research Assistant in Physical Chemistry. Previous research experience is desirable. The post offers considerable scope, and encouragement will be given to obtain higher qualifications. Salary: £650 by £50 to £750 per annum.

Further particulars and form of application may be obtained from the Principal, to whom completed forms should be returned not later than July 9, 1957.

UNIVERSITY OF ABERDEEN

Applications are invited for a Research Fellowship in Physiology. Tenable for two years from October 1, 1957, with possible extension for a third year. Salary in range with maximum £850. F.S.S.U. and children's allowance. Applicants should have had postgraduate experience in physiology or allied subjects and will be expected to join in work on the physiology of autonomic neuro-effectors.

Applications (two copies), containing the names of two referees, should be submitted by July 13, 1957, to the Secretary, The University, Aberdeen.

MEDICAL RESEARCH COUNCIL REQUIRE an Organic Chemist to assist a research group working at the University of Exeter. Applicants should have a good honours degree in chemistry and, preferably, some research experience. The appointment will commence at an early date, and will be for three years, subject to an initial probationary year. Initial salary in range £500 to £690 (to be increased shortly) depending on qualifications and experience.—Applications, with names of two referees, should be sent to the Vice-Chancellor, The University, Exeter, before July 7.

SENIOR LABORATORY TECHNICIAN (male) required for the Department of Chemistry, Chelsea Polytechnic, Manresa Road, London, S.W.3. Applicants, preferably between 24 and 30 years of age, should have had previous laboratory experience. Possession of the City and Guilds Intermediate Certificate in Laboratory Technology (or equivalent) will be an advantage. Salary scale £465 6s. per annum, rising by annual increments of £28 4s. to £578 2s., and with additional increments for specified qualifications to £690 18s. —Apply by letter to the Chief Technician.

SENIOR SCIENTIFIC OFFICERS; SCIENtific Officers. The Civil Service Commissioners invite applications for pensionable appointments covering a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small: individual vacancies exist in the Natural History Museum for candidates who have special knowledge of, or who are interested in, crystallography, taxonomic entomology, palaeobotany, malacology, acarology. Scientific Officers are urgently required for the Forensic Science Laboratories; for scientific examination of document and handwriting cases at Cardiff: for Chemists at Preston, Harrogate, and in London. There is also a vacancy for a Senior Scientific Officer (Biologist) at Harrogate. Candidates must have obtained a university degree with first- or second-class honours in an appropriate scientific subject (including engineering) or in mathematics, or an equivalent qualification, or be otherwise qualified by high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' postgraduate or other approved experience. Age limits: Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted; for Scientific Officers between 21 and 28 during 1957 (up to 31 for permanent members of the Experimental Officer class). Salary (London) Senior Scientific Officers: minimum £1,135 (women £1,047). Men's scale maximum £1,345. Scientific Officers: minimum £605. Men's scale maximum £1,055. Women's pay above £605 slightly lower but being raised to reach equality with men's in 1961. Somewhat lower rates in the provinces. Five-day week, generally.—Further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.53/57 for Senior Scientific Officers and S.52/57 for Scientific Officers. Interview boards will sit at intervals as required. Early application is advised.

OXFORD UNIVERSITY. LABORATORY Technicians required for Research Units. Sound knowledge of chemistry essential and experience of routine biochemical techniques an advantage. Positions are permanent and pensionable, with five and a half to six weeks' paid holiday per annum. Salary according to age, qualifications, and experience.—Applications, giving full particulars, should be sent to Administrative Officer, Department of Biochemistry, South Parks Road, Oxford.

PSYCHOLOGISTS IN THE CIVIL SERVICE

The Civil Service Commissioners invite applications for six posts: two in the Air Ministry (one in the R.A.F. Institute of Aviation Medicine and one in the Scientific Adviser's Organization), three under the Prison Commission and one under the Admiralty for duties at the R.A.F. Institute of Aviation Medicine. The post under the Admiralty is in the Senior Grade, the others are in the basic grade. Both men and women may compete for the post under the Air Ministry at the R.A.F. Institute of Aviation Medicine, but for all other posts men only are eligible.

Age: for Senior Psychologist at least 30 on August 1, 1957; for Psychologist at least 21 and under 31 on that date, with extension for Regular Forces service.

All candidates must possess one of the following qualifications:

(a) A first- or second-class honours degree of a recognized university in which psychology was taken as a main subject.

(b) A higher degree in psychology.

(c) A bachelor of education degree of a Scottish university or of the University of Belfast.

(d) A postgraduate diploma in psychology, following at least two years' systematic study.

(e) Fellowship of the British Psychological Society.

(f) Associateship of the British Psychological Society (subject to certain conditions).

Candidates taking the final examinations for (a), (b), (c), (d) in summer 1957 may be considered.

Exceptionally a candidate without any of these qualifications may be accepted if he has at least three years' responsible professional experience.

London salary (men)—Senior Psychologist, £1,055—£1,460; Psychologist, £565 at age 21 up to £900 (women £882) at age 30. Men's scale maximum £1,190. Women's rate, where lower, is being improved until equality with the men's scale is reached in 1961. Rates somewhat lower outside London. Promotion prospects. Five-day week generally.

Particulars and application forms from Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 75/57/7. Application forms should be returned by July 10, 1957.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

METEOROLOGY DEPARTMENT

Applications are invited for two Lectureships. Experience in meteorology not essential, but candidates should be interested in observational science or fluid dynamics. Primary interest may be experimental or theoretical. Salary £900 by £50 to £1,350 by £75 to £1,650, plus £60 London allowance.

Apply, giving two referees, to Professor P. A. Sheppard, Imperial College, London, S.W.7, by July 27.

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

SHAKESPEARE STREET, NOTTINGHAM

Applications are invited for the post of Assistant, Grade B, in Physics. Salary in accordance with the Burnham Technical Scale, as follows: £650 by £25 to £1,025 per annum. Additions include degree allowance of £75 per annum (or £125 for good honours degree), up to three increments of £25 for training in approved cases and incremental allowance for industrial experience after age 21, and war service. The policy of the College is to encourage staff and students to undertake research work, an appreciable amount being in progress at the present time.

Further particulars and form of application may be obtained from the Principal. Completed forms should be returned not later than July 9, 1957.

SENIOR EXPERIMENTAL OFFICER REquired by the Atomic Weapons Research Establishment, Aldermaston, Berks, to assist in the planning and execution of atomic weapon trials. The work is concerned mainly with arrangements for scientific measurements at the trials. Some overseas duty is involved. Minimum qualification higher school certificate (science) or equivalent, although a general scientific degree desirable. Knowledge of some aspect of atomic weapon effects, and experience of scientific measurements in field trials advantageous. Salary: £1,295 to £1,550 per annum (male). Contributory superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.—Postcards for application forms to the Senior Recruitment Officer at above address. Please quote reference 1524/34.

THE ROYAL SOCIETY

SORBY RESEARCH FELLOWSHIP

The Committee representing the Royal Society and the University of Sheffield, appointed to administer the Sorby Research Fund, invite applications for the post of Sorby Research Fellow. The object of the Fellowship is not to train men for original research but to obtain advances in natural knowledge by enabling men of proved ability to devote themselves to research. The appointment is for five years and will date from October 1, 1957. The stipend of the Fellow will be £1,450 rising by annual increments of £100 to a maximum of £1,850, with superannuation benefits to which the successful candidate will be required to contribute 5 per cent of annual stipend and to which the Society will make a contribution of 10 per cent. The Sorby Research Fellow will be expected to pursue his investigations at the University of Sheffield, unless the nature of the investigation requires that the work should be done elsewhere. The regulations provide that a new appointment shall preferably be in a subject different from the previous one. Accordingly on this occasion, preference will be given to an application which proposes a subject which is not metallurgy. Candidates should supply the usual personal details concerning age, curriculum, distinctions received and qualifications for the research proposed, and give the names of two referees. Testimonials will not be considered. Applicants and referees at a distance may write direct to the address given below, without first obtaining forms. The subject of the proposed research should be given.

Applications should be made on forms to be obtained from the Assistant Secretary, The Royal Society, Burlington House, London, W.1, and should be received not later than July 13, 1957.

NATIONAL COAL BOARD

NORTH-WESTERN DIVISION

Scientist, grade 2 (male), required at Central Laboratory, Physics Section, Shade House, Pendlebury. Salary scale £975 by £35 to £1,360 per annum. Applicants should have a first- or second-class hons. degree in physics or an equivalent qualification. Will be expected to work underground on investigations on dust and allied problems as required.

Applications, stating age, education, qualifications, experience and present post, to the Divisional Chief Staff Officer, 40 Portland Street, Manchester, 1, within 10 days.

UNIVERSITY OF MELBOURNE

AUSTRALIA

Applications are invited for two positions of Reader (or Senior Lecturer) and Senior Lecturer in Statistics. Applicants should be qualified in mathematical statistics and, for the more senior position, widely experienced in the application of statistics to practical and managerial problems. The salary ranges are £A.2,200 to £A.2,400 for a Reader and £A.1,850 to £A.2,150 for a Senior Lecturer. Initial salary will be determined by qualifications and experience. Superannuation similar to F.S.S.U. in Great Britain will be provided.

Conditions of appointment may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close in Australia and London on August 15, 1957.

UNIVERSITY OF SASKATCHEWAN

CANADA

DEPARTMENT OF PHYSICS

POST-DOCTORAL RESEARCH FELLOWSHIP

Applications are invited for a Post-doctoral Research Fellowship in upper atmospheric physics. The research to be undertaken involves the investigations of the spectrum of the aurora and airglow in the PbS region.

Further information may be obtained by writing by airmail to Dr. A. Vallance Jones, Department of Physics, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Assistant Lecturer in Mathematics. Candidates should have qualifications in either pure or applied mathematics. The salary scale is at present under review and is expected to be £700 to £850 per annum. Membership of F.S.S.U. and children's allowance scheme.

Applications should be sent not later than July 10, 1957, to the Registrar, The University, Manchester, 13, from whom further particulars and forms of application may be obtained.

WELSH PLANT BREEDING STATION

UNIVERSITY COLLEGE OF WALES ABERYSTWYTH

Applications invited from candidates with pass degree in botany or other suitable qualifications for posts in assistant experimental officer grade in cytology, plant genetics, grassland agronomy, and chemistry. Salary age scale basis: men £350 to £755, and women £350 to £693 (equal pay stage III). Superannuation scheme.

Further particulars from the Registrar, to whom applications, with copies of two recent testimonials and names of two referees, should be sent by July 6.

UNIVERSITY COLLEGE OF RHODESIA AND NYASALAND

Applications are invited for two Lectureships in Botany from candidates interested in mycology and cytogenetics. Salary scales: Assistant Lecturer, £1,050 by £50 to £1,200 per annum; Lecturer (Grade II), £1,200 by £50 to £1,450 per annum; (Grade I), £1,450 by £50 to £1,750 per annum. Entry point determined by qualifications and experience. Superannuation scheme. Passages to Salisbury for appointee, wife, and dependent children on appointment, with allowance for transport of effects. Unfurnished accommodation at rent of up to 15 per cent of salary.

Detailed applications (six copies), naming three referees, by August 15, 1957, to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

PUBLIC RELATIONS

A.E.R.E., HARWELL

has a vacancy in the section whose duties include organizing official visits to the Establishment, conferences, lecturers, technical exhibitions; preparation of popular accounts of technical work.

G.C.E. (A), H.N.C., or equivalent, and wide interests in the physical sciences.

£940 (at 26) to £1,155 or £375 (at 18), rising to £815.

Send postcard (quoting 825/34) for further details and an application form, which must be returned by July 14, 1957, to Group Recruitment Officer, A.E.R.E., Harwell, Didcot, Berks.

CENTRAL ELECTRICITY AUTHORITY

HEADQUARTERS

require ENGINEERS in the Station Planning and Development Branch in London, S.E.1.

The Branch is responsible for: (a) investigation and selection of sites for nuclear power stations; co-ordination of investigations and selection of sites for orthodox stations; negotiations for statutory and other consents for both classes of stations; (b) formulation of initial basic designs of new orthodox power stations including layout of sites and stations; railway sidings; circulating water systems; development of works power supply schemes; plant control schemes. All candidates should have an honours degree or qualifications for membership of the I.Mech.E., I.C.E., or I.E.E., and for (a) preferably experience of economic studies or of one or more of the problems arising in the siting of power stations, e.g., geology and ground exploration; thermal and hydraulic aspects of the use of river and sea water for cooling purposes; discharge and disposal of chimney emissions; questions of town and country planning. Candidates for (b) must be experienced in the design and layout of large modern power stations and associated plant, and experience of the construction or operation of such stations would be an advantage.

Salaries within scales:

Senior Assistant Engineer: £1,435 to £1,795 per annum.

Second Assistant Engineers: £1,210 to £1,570 per annum.

Third Assistant Engineer: £1,105 to £1,315 per annum.

Fourth Assistant Engineer: £870 to £1,045 per annum.

Application forms, obtainable from D. Moffat, Director of Establishments, Winsley Street, London, W.1, should be completed and returned by July 11. Quote ref. N/281.

UNIVERSITY COLLEGE OF RHODESIA AND NYASALAND

Applications are invited for a Lectureship in each of the following subjects: Agriculture (Pedology and Soil Science); Agriculture (Animal Nutrition); Agricultural Chemistry; Agricultural Zoology. Salary scales: Assistant Lecturer, £1,050 by £50 to £1,200 per annum; Lecturer (Grade II), £1,200 by £50 to £1,450 per annum; (Grade I), £1,450 by £50 to £1,750 per annum. Entry point determined by qualifications and experience. Superannuation scheme. Passages to Salisbury for appointee, wife, and dependent children on appointment with allowance for transport of effects. Unfurnished accommodation at rent of up to 15 per cent of salary.

Detailed applications (six copies), naming three referees, by August 15, to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

PRINCIPAL SCIENTIFIC OFFICERS. THE Civil Service Commissioners invite applications for pensionable posts (a) Admiralty, nine; (b) British Museum—Natural History, one; (c) Department of Scientific and Industrial Research, nine; (d) Ministry of Supply, 20. Age at least 31 on December 31, 1956. Candidates must have first- or second-class honours degree, or equivalent, in an appropriate subject and at least three years' approved research experience. Candidates exceptionally well qualified by experience may be admitted without the academic qualifications. For all posts candidates must have had several years' appropriate experience and be of proved research ability. Under (a) five posts are for Physicists, one for a Physical Chemist, one for a Mechanical Engineer, and one for an Electrical Engineer. The posts are at naval establishments in the southern half of England; duties involve taking charge of research design and development work. There is also a mathematics post for the analysis and reduction of data. Under (b) a specialist in the taxonomy of European flowering plants is required. Under (c) three of the posts are at the Laboratories at Teddington—one in the Ship Division, one in the Radiochemistry Section, and one in the Metal Corrosion Section; one is in the Road Research Laboratory at Langley, Bucks, one at the Mechanical Engineering Laboratory at East Kilbride, near Glasgow, for experimental and theoretical research in hydrodynamics and low-speed aerodynamics, one at the Low Temperature Research Station at Cambridge for research on food microbiology, one in London to act as liaison officer in the field of processing and metallurgy, one in Edinburgh to act as liaison officer on matters relating to scientific research and development. The work entails extensive travelling and lecturing, and one in London on administrative duties on Department's scientific policy and its choice of programmes and allocation of resources. The posts for (d) are classified under Applied Mathematics, Physics, Aeronautical and Mechanical Engineering, Electrical Engineering, Chemistry, and Metallurgy for work on guided weapons, electronics, aerodynamics, radio, radar, etc. Fuller information about the duties and the kind of experience expected is given in the memorandum. Salary (London) minimum £1,375 (women £1,288). Men's scale maximum £1,950. Exceptionally, starting pay above minimum. Somewhat lower outside London. Women's scale is being raised to reach equality with men's by 1961.—Application forms and memorandum from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4714/57/15. Applications to be returned by July 18, 1957.

THE AGRICULTURAL RESEARCH COUNCIL require an Assistant Experimental Officer in the Experimental Pathology Department at their Institute of Animal Physiology to work on electrophoresis. Minimum qualifications: G.C.E. in five subjects, including two subjects (mathematics or science) at advanced level, or equivalent. Preference would be given to candidates with a pass degree in science, or laboratory experience in biochemistry, biophysics, or immunology. Salary according to age in scale £390 at 19 to £755. Contributory superannuation scheme.—Applications, with the names of two referees, to the Secretary, Institute of Animal Physiology, Babraham, Cambridge, within two weeks.

ROYAL MARSDEN HOSPITAL, FULHAM Road, S.W.3. Applications are invited for the post of Technician in the Endocrinology Laboratory. Candidates should have had some experience in clinical biochemistry and be interested in biological work. Salary and conditions of service according to Whitley Council scale.

UNIVERSITY OF BRITISH COLUMBIA

DEPARTMENT OF CHEMISTRY

Applications are invited for the posts, (a) Instructorships (salary $4,500 per annum), and (b) Assistant Professorships (minimum salary $5,000 per annum). Candidates should have the Ph.D. degree, or its equivalent, in inorganic or physical chemistry. Some university teaching experience is required for appointments to the Assistant Professorships. Successful candidates will be expected to pursue research in one of the following fields: chemical kinetics, electron and nuclear magnetic resonance spectroscopy, mass spectrometry, radiation chemistry, molecular structure, or modern inorganic chemistry.

Applications, with the names and addresses of two referees, should be sent to the undersigned, from whom further particulars may be obtained.

Professor C. A. McDOWELL,
Department of Chemistry,
University of British Columbia,
Vancouver 8, B.C., Canada.

INSTITUT NATIONAL POUR L'ETUDE AGRONOMIQUE

DU CONGO BELGE

Applications are invited from British graduates for appointment as Statistician in the Division of Biometry, Yangambi, district of Stanleyville, Belgian Congo, for work in the design of field experiments, biological assay and sample surveys, and for programming work on I.B.M. equipment.

Detailed applications, stating age, education, experience and qualifications, should be made in confidence to the Director General of the I.N.E.A.C., 12 rue aux Laines, Brussels.

RESEARCH FELLOWSHIPS IN GOVERNment Scientific Establishments. The Civil Service Commissioners invite application for a number of Senior and Junior Research Fellowships, tenable for three years at Government Scientific Establishments, for research into subjects of importance to H.M. Government. There are no age limits, but candidates must normally have a first- or second-class honours degree in an appropriate subject and must be able to show evidence of a very high standard of ability in research. At least two years' postgraduate experience will be expected of candidates for Junior Fellowships and at least three years of candidates for Senior Fellowships. Exceptionally a candidate without the academic requirement, but who can produce evidence of outstanding ability in research, may be admitted. Remuneration will be according to individual merit and experience, at rates between £1,000 and £1,200 for Senior Fellowships and between £650 and £850 for Junior Fellowships. F.S.S.U. scheme applies. The fields of research in which Fellowships may be awarded if candidates of the requisite high quality present themselves cover a very wide range; and Fellowships may be tenable at any of a considerable number of Scientific Establishments.—Further information, and application forms, from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4695/57. Interview board sits at intervals, as required. Early application advised.

METEOROLOGICAL OFFICE, SCIENTIFIC Officers. The Civil Service Commissioners invite applications for permanent posts. The duties include research in atmospheric physics, covering the study of cloud structure, synoptic and dynamical meteorology, large- and small-scale diffusion and turbulence, climatology, and development of instruments. There is a limited number of posts for forecasting work at the more important centres. Successful candidates will be given a course in meteorology before being assigned to a research or forecasting establishment for further training and experience. In some instances candidates with national service obligations can be commissioned in the R.A.F. for forecasting duties at R.A.F. stations. Further information may be obtained from the Director, Meteorological Office (M.O. 10), Air Ministry, Kingsway, London, W.C.2. Candidates must be between 21 and 28 during 1957. They must have a first- or second-class honours degree, preferably in physics or mathematics, or an equivalent qualification. Salaries (London rates) £605 to £1,055. Women's pay above £605 slightly lower but being raised to reach equality with men's in 1961. Somewhat lower rates in provinces. Opportunities for promotion to Senior Scientific Officer (£1,135 to £1,345) and higher posts.—Particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.52/57 (Met.). Interview boards will sit at intervals as required. Early application is advised.

UNIVERSITY OF SHEFFIELD

Through the generosity of Batchelors Peas Ltd. the University offers a Research Fellowship in Biochemistry or Microbiology, open to graduates of any British university. The Fellowship will be tenable initially for a period of two years and may be extended for a third year. Value £450 a year. The Fellow will be required to pursue a full-time course of research in the University of Sheffield under conditions approved by the Head of the Department concerned.

Applications (two copies) including the names and addresses of referees and, if desired, copies of testimonials, should reach the Registrar (from whom further particulars may be obtained) by July 20, 1957.

CENTRAL ELECTRICITY AUTHORITY

NUCLEAR POWER SUBDEPARTMENT

require, in London, S.E.1, METALLURGISTS to advise on the suitability of metals for use in reactors and fuel elements, and to study the problems arising therefrom. Candidates should have a good knowledge in the fields of ferrous and non-ferrous metallurgy and a knowledge of cermets would be advantageous. Industrial experience and a good degree of a British university or equivalent qualification is desirable. The appointments will necessitate liaison with the laboratories of this and other organizations. Salaries within scales £870 to £1,795 per annum according to ability.

Applications, stating age, qualifications, experience, present position, and salary, to D. Moffat, Director of Establishments Winsley Street, London, W.1, by July 3. Quote ref. N/265.

STATISTICIAN

required by N.C.B.'s Statistics Branch at London Headquarters. Applicants should have degree in mathematical statistics or mathematics with appropriate qualifications in statistics. The work is interesting, varied, and largely of a consultative nature.

Appointment (superannuable), according to qualifications and experience, within inclusive ranges £1,020 to £1,300 male, £925 to £1,205 female.

Write, stating age, qualifications and experience, to National Coal Board, Staff Dept., Hobart House, London, S.W.1, marking envelope X/724/2D, before July 8, 1957.

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer in the Department of Physiology. The salary scale for a medically qualified candidate will be £900 by £100 to £1,100 per annum (initial salary £900 per annum); the salary range for a non-medically qualified candidate will be £700 to £850 per annum.

Applications, stating age, qualifications, and experience, together with the names of three referees, should be received not later than July 13, 1957, by the Registrar, from whom further particulars of the conditions of appointment may be obtained.

LAVAL UNIVERSITY

QUEBEC, CANADA

Vacant staff position to teach inorganic chemistry in French at the undergraduate and graduate levels. Excellent facilities for research. Salary and academic status (Assistant or Associate Professor) commensurate with qualifications and experience.

Apply to the Director of the Chemistry Dept., Laval University, Quebec, Que., Canada.

ASSISTANT PHYSICIST REQUIRED, RADIOtherapy Department, Royal South Hants Hospital, Southampton. Appointment will be at basic grade within the salary scale £525 by £25 to £625, and subsequently £650 by £30 (3) by £35 (3) to £845 per annum. Candidates must have an honours degree in physics, but previous hospital experience is not essential. Duties will be to assist in radium and x-ray problems, including rotational therapy, as well as radioisotope work.—Applications, stating age, qualifications, and experience, giving the names of two referees, should be sent as soon as possible to Frank Jennings, Secretary, Southampton Group Hospital Management Committee, Bullar Street, Southampton.

SHEFFIELD CENTRE FOR THE INVESTIGATION AND TREATMENT OF RHEUMATIC DISEASES

Organic Chemist required to work with a team in the steroid field. Ph.D. preferable. Terms and conditions as for biochemists in the National Health Service. Salary starting range £650 to £910 per annum according to qualifications and experience. Tenure one year, with renewal for a further two years anticipated.

Apply, stating age, qualifications, experience, etc., together with the names of two persons for reference, to the Group Secretary, Sheffield No. 1 Hospital Management Committee, Nether Edge Hospital, Sheffield, 11.

UNIVERSITY OF ST. ANDREWS

QUEEN'S COLLEGE, DUNDEE

LECTURESHIP IN PHYSICS

The University Court of the University of St. Andrews invites applications for a Lectureship in Physics in Queen's College, Dundee, commencing October 1, 1957. The salary will be on the scale £900 by £50 to £1,350 by £75 to £1,650, with efficiency bar at £1,350. F.S.S.U. and family allowance benefits; a grant towards removal expenses will be made.

Six copies of the application, which should contain the names of three referees, should be lodged with the undernoted not later than July 6, 1957.

PATRICK CUMMING,
Joint Clerk to the University Court.

BLOOD GROUPS.—A SMALL TEAM WORKing on blood groups in cattle requires (a) Scientist, honours graduate seeking research career, to study an immunological problem in twin cattle and search for new reagents. Scientific Officer scale £585 to £1,025 (women £955 subject to equal pay improvement), F.S.S.U. (b) Assistant Experimental Officer to prepare and apply known reagents under guidance. Experience of immunology, haematology, or blood-group work an advantage but not essential. Assistant Experimental Officer scale £470 (at age 21) to £780 (women £713 subject to equal pay improvement). A.R.C. superannuation scheme.—Applications, with names of three referees, by July 20, to Secretary, A.R.C., Animal Breeding Research Organization, 6 South Oswald Road, Edinburgh, 9.

APPOINTMENTS VACANT

PHARMACOLOGIST OR PHYSIOLOGIST required by an expanding pharmaceutical company for their new Pharmacology Department. The position will appeal to those recently qualified or expecting to graduate this year. The work will be part of an interesting research programme. It will consist of the screening of new compounds for a variety of pharmacological actions and a more detailed study of those of potential therapeutic value. Publication of results is encouraged and the position offers excellent prospects to anyone with real ability. Salary according to qualifications and experience. The company work a five-day week and operate an attractive non-contributory pension scheme.—Apply with full particulars to Personnel Officer, Smith, Kline & French Laboratories Limited, 120 Coldharbour Lane, London, S.E.5.

IMPERIAL CHEMICAL INDUSTRIES LIMIted, Dyestuffs Division, has vacancies in its Research Department for Physicists to work on a variety of physical and instrumental problems associated with the development and manufacture of photographic materials for the recently introduced "ICHCOLOR" process of colour photography. Applications are invited from Physicists with good honours degrees and preferably with experience of physical optics, electronics, or colorimetry. These appointments carry attractive starting salaries which depend upon age, experience, and qualifications.—Please write, giving brief details of age, qualifications, and experience, to Staff Department, Hexagon House, Blackley, Manchester, 9, quoting Reference I/12.

BOOTS PURE DRUG CO. LTD. HAVE A vacancy in the Veterinary and Horticultural Division of their Development Laboratory for a Qualified Chemist, preferably with industrial experience, to work on the formulation and development of veterinary and animal husbandry products.—Applications should be addressed to the Personnel Manager, Station Street, Nottingham.

HAWKER SIDDELEY NUCLEAR POWER CO. LTD.

invites applications from

GRADUATES

in

Physics or Electrical Engineering

to work on design of special instruments and/or complete reactor instrumentation systems.

Research or development experience in design of electronic measuring devices or instrumentation systems essential. Experience in nuclear physics or pneumatics an added qualification. Age 25-35.

The post is pensionable subject to the normal qualifying period.

Please write to Personnel Officer, Sutton Lane, Langley, nr. Slough, Bucks.

DISTILLERS COMPANY LIMITED

ANALYTICAL OR PHYSICAL CHEMIST

The Company have a vacancy at the Speke, Liverpool, factory of the Distillers Company (Biochemicals) Limited for a male Analytical or Physical Chemist, aged not over 30, to develop automatic laboratory control procedures and other physicochemical techniques; he will work in conjunction with specialists in the field, both inside and outside the Company. Candidates should hold a good honours degree in chemistry, or an equivalent qualification; experience in pharmaceutical or fine chemical manufacture is desirable, but is not essential. Salary according to qualifications and experience. Non-contributory pension scheme.

Write Staff Manager, The Distillers Company Limited, 21 St. James's Square, London, S.W.1. Quote Ref. 31/57.

DISTILLERS COMPANY LIMITED

In step with its rapidly expanding interests in many branches of the chemical industry, the Company wishes to appoint a limited number of

CHEMICAL ENGINEERS

initially to the staff of its Research and Development Department, Epsom, Surrey.

To men with initiative each vacancy offers scope for a wide range of activities, from initial theoretical design and calculations on the one hand, to participation in the final erection and commissioning of full-scale plant on the other, and including intermediate work, for example, on the pilot-plant scale.

Candidates should have a good honours degree in chemical engineering, or equivalent qualifications, and should be aged preferably not over 30. Salary according to qualifications and experience. Non-contributory pension scheme.

Write Staff Manager, The Distillers Company Limited, 21 St. James's Square, London, S.W.1. Quote Ref. 33/57.

REQUIRED FOR INTERESTING research development work on electro-acoustic devices an Engineer up to B.Sc. standard.—Apply Box No. 874, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

VACCINES

AN internationally famous and rapidly expanding drug and fine chemical organization is about to enter the field of vaccines. Although interest in the field will be general and will extend through all phases of Research and Production, initial developments will be tied to a particular project making a major advance in products of its type.

A vacancy arises for a man with experience especially in virus work to lead a team initially in developing the project and eventually of supervising its eventual operation and/or carrying out further and more general research and development work in the broader field.

The position calls for a first-class man with a pioneering spirit, and a generous salary will be paid to the successful applicant.

The Company is situated in a non-industrial and pleasant area, operates a non-contributory pension scheme, and generally offers above average opportunities and conditions.

Applications, which will be treated in the strictest confidence, giving full details as to qualifications, age, experience, etc., to Box 893, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

PHYSICISTS

Are you interested in Properties of Materials?

BAKELITE LIMITED have a vacancy in the Physics Section of their Development Department for a PHYSICIST (aged 25 to 35) to work on the electrical and mechanical properties of a wide variety of synthetic resins and allied products. Previous experience in this field is desirable but not essential, a more important requirement being a good honours degree in physics. Salary according to age and experience.

Applications, giving details of age, training and qualifications, should be addressed to Development Manager, Bakelite Limited, Redfern Road, Tyseley, Birmingham, 11.

IMPERIAL CHEMICAL INDUSTRIES LIMITED, Dyestuffs Division, has a vacancy for a Scientific Glass-blower at Dalton Works, Huddersfield. A man aged 25 years or over with experience in fabrication and repair of scientific glassware would be offered Assistant Technical Officer grade; a younger man with similar qualifications may be recruited initially in the Laboratory Assistant grade of staff.—Apply in writing to the Staff Officer, Imperial Chemical Industries Limited, Dyestuffs Division, P.O. Box A.38, Huddersfield.

BACTERIOLOGIST (MALE OR FEMALE) required in Laboratory situated in West End of London. Work mainly concerned with testing disinfectant formulations for medical, public health, and dairy work.—Write, stating age and qualifications, Box 899, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

PILKINGTON BROTHERS LIMITED, WHO are the largest manufacturers of plate and sheet glass in the British Commonwealth and employ more than 20,000 persons, wish to appoint a Head of their Technical Development Department. This is a new appointment necessitated by the large number of development projects in hand. It is intended that the man selected should take charge of the development of new processes and the radical improvement of existing ones. There are ample technical resources available and the Company spends large amounts on development work. Applicants must have a good honours degree in engineering, physics, or chemistry. They must also have a flair for development work and the enthusiasm to see a job through. Applications will be welcomed from men aged preferably 35-45 who have done at least five years' successful and original development work in industry or at a university. The Company is prepared to offer a service agreement at an attractive salary to the right man.—All applications will be treated confidentially and should be addressed to the Group Personnel Officer, Pilkington Brothers Limited, The Glass Works, St. Helens, Lancashire.

DUNLOP RUBBER COMPANY HAVE A vacancy in their Patent Department for a Technical Assistant, preferably graduate, with engineering knowledge, to assist in the preparation and conduct of patent applications at home and abroad. Patent experience is desirable but not essential.—Please apply, in writing, to Personnel Manager, Fort Dunlop, Birmingham, 24, quoting reference J.M. 117.

INFORMATION OFFICER REQUIRED, either sex, 22-27, for export marketing member of light engineering group in outer London (Essex). Technical and/or economic background and qualifications, and training in analytical indexing and information (not publicity) work necessary. Progressive salary according to age and experience. Five-day week. Good staff conditions. Canteen facilities available.

Please reply, giving full details, to Box 900, T. G. Scott and Son, Ltd., 1 Clement's Inn, London W.C.2.

AN OPPORTUNITY FOR

CHEMISTS

IN THE FIELD OF

TECHNICAL SALES

There are openings for two Chemists to become technical salesmen, after training in the laboratories and on the selling side of our Compositions Division, to handle their varied range of products. Applicants should have a degree in Chemistry or a City and Guilds Certificate in Paint Technology.

At the end of the training period, these men may be required to travel overseas to carry out their duties in any manufacturing territory. Single men are, therefore, suitable, or married men quite willing to leave home for periods of up to six months. Salary will be commensurate with responsibilities, and expenses when overseas fully covered.

Those interested should write, in confidence, giving age, experience and salary, to Personnel Manager (CD), Fort Dunlop, Birmingham, 24.

THE MULLARD RADIO VALVE CO. LTD.

require a

GRADUATE CHEMIST

to work in the Material Research Laboratory for research on ceramic materials used in the electronics industry. The work will involve an interest in ferrites, dielectrics, or insulators, and although previous experience in this field is not essential it would be an advantage.

The post is pensionable and progressive.

Applications, in writing, should be addressed to the Personnel Officer, The Mullard Radio Valve Co. Ltd., New Road, Mitcham Junction, Surrey, quoting reference JFG/MRL.171.

RESEARCH CHEMIST. RESEARCH Laboratory serving Group of Companies active in the petroleum, petroleum chemicals and chemical engineering field requires young graduate for interesting research in petroleum and heavy organic chemicals. Minimum: first- or second-class honours degree. Some industrial experience preferred but not essential. Pension scheme, etc., north-west location.—Apply Box 898, T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2.

QUALITY CONTROL APPLICATIONS ARE invited for the post of Quality Control Statistician in a rapidly expanding tungsten manufacturing plant, situated in the London area. Candidates should possess a degree in mathematics and statistics or equivalent qualifications, with some experience in analytical methods, design of experiments, sampling and inspection schemes, sequential analysis and related techniques, and have the ability of developing and applying these methods to specific quality control problems arising in production. The work is interesting, covering a wide field of investigation with scope for original research and contributions. The appointment will carry a good initial salary according to qualifications and experience, and the prospects for advancement within the organization are excellent.—Apply in writing, giving full details of curriculum vitae, to Chief Scientific Officer, The Tungsten Manufacturing Co. Ltd., 8 Heddon Street, London, W.1.

CHEMISTS, PREFERABLY WITH HONOURS degree, required by the British Drug Houses Ltd. for Development Research in connection with organic chemicals. The work relates to bulk and fine chemicals and chemotherapeutic substances. Commencing salary will be according to qualifications and experience. Five-day week. Pension and profit-sharing schemes. Canteen and sports club.—Apply in writing, stating age, qualifications, experience, and salary required, to Staff Manager, Graham Street, N.1.

Imperial Chemical Industries Limited

Billingham Division

Vacancies for

MATHEMATICIANS

There are vacancies in this Division for Mathematicians with good honours degrees who are interested in applied branches of the subject and particularly in developing the use of high-speed electronic computers. The Mathematical Section of the Billingham Research Department deals with a wide range of theoretical and practical problems arising from research in physics, chemistry, engineering, chemical plant design and operation. There is scope both for research in applied mathematics and in the evolution of high-speed computing techniques on a modern electronic machine. The work is closely associated with research and production in a very large chemical organization, and there are many opportunities of advancement.

Appointments are pensionable and there is a profit-sharing scheme in operation. Assistance can be given towards house purchase and removal expenses in the case of married men.

Write, giving brief details of qualifications and experience, to the Staff Manager, Imperial Chemical Industries Limited, Billingham Division, Billingham, Co. Durham, quoting Ref. No. W/R/4.

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The Personnel Manager,
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BRITISH-AMERICAN TOBACCO COMpany Limited wish to recruit for vacancies in their new Research Centre at Southampton. Inquiries are invited from graduates between 24 and 28 with some research experience in organic or physical chemistry and mechanical engineers of the same age with a sound knowledge of physics or electronics. These appointments are concerned with an interesting field of investigation and carry excellent salary, conditions and prospects.—Apply by letter to Personnel Manager, British-American Tobacco Company, Limited, Westminster House, 7 Millbank, London, S.W.1.

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Applications are invited for the post of Assistant Bacteriologist in the Laboratories of A. & G. Nicholas Limited. The successful candidate will be required to carry out bacteriological product control work and also some research. Applicants must have experience in media preparation, general bacteriological techniques, and preferably hospital experience. Possession of the A.I.M.L.T. or F.M.I.L.T. will be an advantage. The commencing salary offered is £550 to £600 per annum.

Please quote ASST/BACT. Apply Personnel Manager, A. & G. Nicholas Limited, Buckingham Avenue, Slough, Bucks.

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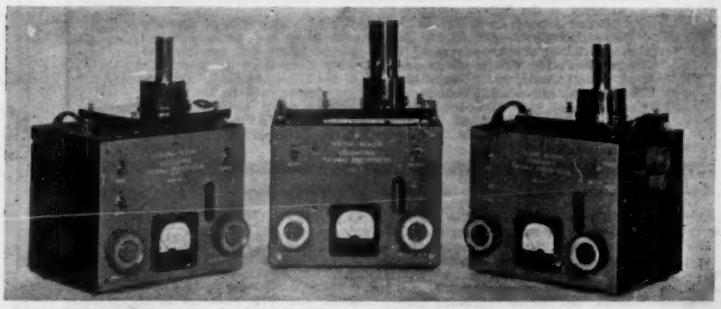

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